" Strengthening fisheries management in ACP states "

FINAL TECHNICAL REPORT

TRAINING IN UNDERWATER VISUAL SURVEY METHODS FOR EVALUATING THE STATUS OF STROMBUS GIGAS, QUEEN CONCH STOCKS

ACP Fish II – Strengthening fisheries management in ACP states

9 ACP RPF 128 Accounting No. RPR/006/07 – EDF IX

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Abbreviations and Acronyms

AUV	Autonomous Underwater Vehicle
CARICOM	Caribbean Community and Common Market
CARIFORUM	Forum of the Caribbean Group of African, Caribbean and Pacific (ACP) States
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLRWG	Conch and Lobster Resource Working Group
CFO	Chief Fisheries Officer
CFRM	Caribbean Regional Fisheries Mechanism
ESDU	Environmental Sustainable Development Unit (of OECS)
FD	Fisheries Division
GCFI	Gulf and Caribbean Fisheries Institute
GIS	Geographic Information System
GPS	Global Positioning system
IUU	Illegal, Unregulated and Unreported (fishing)
KE	Key Expert
MARSIS	Grenadines Marine Resource and Space-use Information System
MPA	Marine Protected Area
NGO	Non Governmental Organization
OECS	Organization of Eastern Caribbean States
RFU	Regional Facilitation Unit
ROV	Remotely-Operated Vehicle
SVG	St. Vincent and the Grenadines
TAC	Total Allowable Catch
ToR	Terms of Reference
TT	Technical Team

Executive summary

This project was designed to build the capacity of fisheries officers in using underwater visual survey methods for the management of *Strombus gigas*, queen conch. The project interfaced closely with the CRFM Secretariat which has regional responsibility in both fisheries management and in supporting national administrations. Representatives from the following countries were involved in the training: Antigua and Barbuda, The Bahamas, Belize, Dominican Republic, Grenada, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines. In general the participants were fisheries officers; however, there were two commercial conch fishers who also participated in various aspects of the training.

The project was implemented in two phases. In the **Phase** 1, the Key Experts (KEs) met in Kingstown St. Vincent from June 3-14, 2013 to engage in meetings with the project administrators, to gather information on the fishery independent methods applied throughout the region, and to coordinate field for phase 2 of the project. More specifically. the Key Experts participated in the presentation of the outputs from the ACP Fish II project: *Support to improve and harmonize the scientific approaches required to inform sustainable management of queen conch (Strombus gigas) by CARIFORUM States (Project ref. N°: CAR/3.2/B.15).*The KEs also visited Union Island to arrange the details that were required for the in-water portion of Phase 2. These details included identifying an appropriate hotel for the training and obtaining quotes, and discussing logistical details with the local dive operator, Grenadines Dive. Subsequently, the KEs met with fisheries officers participating in the Queen conch and Lobster Working Group meeting in Kingstown thus facilitating the acquisition of additional queen conch survey information. The KEs explored options for renting an underwater video-camera and met with Dr. Kim Baldwin who has used the equipment for mapping the shelf around the Grenadine Islands. This option was ultimately recommended as the best approach.

Upon leaving St. Vincent, the KEs created two documents as required in the Terms of Reference. These documents were 1) a Training Manual which focused on all phases of queen conch biology, sampling strategies, development of quotas, structure of a sampling program, and the use of GPS and GIS, and 2) an assessment of all published and unpublished information in which fisheries independent assessments of *S. gigas* were conducted in the Caribbean region. Documents were given to the fisheries officers for its revisions and recommendations.

Phase 2 consisted of three stages and was conducted in both St. Vincent and Union Islands, as follows:

> **Stage** 1, The Key Experts prepared and offered background lectures on queen conch biology, conservation, habitat requirements, regional connectivity, and critical issues related to reproduction. In preparation for the mock survey, theoretical/practical lessons focused on sampling design, sampling methodologies, use of GPS and GIS using free software, and safety at sea were also presented. At the conclusion of this stage, determination of the appropriate study/sampling area was based on distance from the port, depth for maximize diving, availability of spatial data locations and other considerations. The study sites were uploaded by several trainees to the GPS units that they brought to the training. These activities were completed using PowerPoint presentations, class

exercises, video documentaries, internet search exercises, group discussions, and webinars. Stage 1 was conducted at the CRFM office in Kingstown, St. Vincent.

Stage 2, consisted of a practical mock survey of the waters in and around Union Island, Mayreau, Palm Island, and the Tobago Keys Marine Park in the Grenadines. To ensure that safety was maintained, a Dive Safety Plan was developed (Annex IV.2). The selection of the project area for training was based on practical considerations (e.g., distance from the port, available spatial data). Spatial data that was used to develop the survey plan; It came directly from the developer of the MARSIS database (http://grenadinesmarsis.com/) which is a comprehensive spatially-explicit database of resources and their use, habitat, bathymetry, and zoning in The Grenadines.

Additional techniques were explored including the use of a towed video camera for deepwater surveys, and plankton sampling to help inform the origin of local conch stocks. More information about the mock survey can be found in Annex which details the methods and results of the Mock Survey.(Annex IV.1)

During stage 2, participants began to work on their country strategies for future surveys under the supervision of the KE.

Stage 3.

This stage consisted of a review and analysis of the data that was collected during Stage 2 and interpretation of the results, The trainees were instructed in all phases of data analyses using Microsoft Excel® including the estimation of overall densities for both adult and juvenile *S. gigas*, estimation of total populations size, calculation of the total biomass for the sample area, and determination of total allowable catches (TAC) using guidelines from CITES. Additionally, the exercises included spatial exploration of the data within a GIS

The trainees were also guided to make recommendations to fisheries authorities on how to achieve sustainable harvests based on their calculations (through exercises).

A press event to share the preliminary results, closing ceremony and an overall project evaluation were part of this stage 3, which took place again in Kingston, St Vincent.

During stage 3, participants continued to work on their country strategies for future surveys under the supervision of the KE.

1. Background

Queen conch, *Strombus gigas*, is a large mollusk that supports one of the most important fisheries in the CARICOM/CARIFORUM region. Populations of queen conch can be found along the entire Caribbean chain, from the northern coast of South America, northwards through the Lesser Antilles and Central America, and northwest as far as Bermuda. Queen conch is commercially exploited in at least 22 countries throughout the region, with an estimated landing valued at about 60 million USD. The fishery represents a significant source of income to fishers and creates jobs for the processing and marketing, ornamental, tourist, and restaurant industries in the region. Annual regional harvests for conch meat range from 4,000 MT to 10,200 MT[1]. Significant quantities of conch shells have been exported from the region, with much of the activities originating from Haiti, The Bahamas and the Turks and Caicos Islands (FAO 1999).

In the last 30 years the overall harvest of conch has increased substantially, largely driven by international market demand, as well as growing resident populations, increasing tourism in the Caribbean region, and the expansion of the fishery into previously unexploited deeper waters. These factors have been the main contributors of the dramatic decline in conch population densities in several Caribbean countries, which led to the inclusion of queen conch on Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) in 1992. Since then, CITES has progressively stepped up pressure on states to adopt resource management and its international trade measures to protect and conserve the stocks and to promote sustainable utilization of the species (Theile 2001).

The need for a common regional approach to manage the queen conch fishery has been identified as the way forward for CRFM Member States. The main issues that require attention in the regionally context are: IUU fishing activities, including poaching and illegal trade; abundance and landings monitoring; enforcement and surveillance; the degree of resource sharing through larval dispersal; and regional cooperation in management, including the harmonization of management regulations such as a closed season which could help to reduce illegal fishing. All these issues could be addressed and effectively reduced at the regional level with the cooperation and commitment of Member States, therefore CRFM Secretariat has taken the task of coordinating conch management in the region. The overall objectives of queen conch management, as identified by Member States, are conservation of the species, sustainable harvest, and re-building of stocks, where depleted.

The CRFM Secretariat established the annual scientific meetings to examine information and data from important commercial species including conch to determine their status, and if management objectives are being met and thus achieve these objectives.The findings and recommendations of these meetings guide fisheries management and decision-making.

The Conch and Lobster Resource Working Group (CLWG) is one of five working groups that conduct fisheries assessments, and it currently strives to provide advice on conch stock/population status and to facilitate the development of appropriate management strategies.

[1] Source ACP FISH II ToR of this project CAR/3.2/B14

To address these needs, ACP Fish II Programme funded this project with the purpose of building capacity among fisheries officers in the target group in using underwater visual survey methods for the assessment and management of *Strombus gigas*, queen conch.

The following outputs were completed by SOFRECO in reference to the assignment:

- Report prepared analyzing fisheries independent approaches for assessment of queen conch in the Caribbean context;
- Training manual on underwater visual survey techniques in the Caribbean developed;
- Fisheries officers trained in use of underwater visual survey techniques.
- Report of Training Workshop completed, including the report of mock survey, visual survey designs for participating countries, and recommendations for implementing the proposed survey design.

2. Approach to the assignment

The project was developed in two phases. The first was conducted between June 1 and June 24, 2013 (see Annex I – Inception report for details). During this time, Key Experts (KE) worked in St. Vincent and Union Island as well as at their home stations. During the first 12 days (June 2 – June 14), they participated in briefings, defined the field work operations and the best strategies, determined the area(s) to be surveyed, and planned several additional logistical details that were required for Phase II of the project.

During phase I, the KEs actively participated in the Regional Validation Queen Conch Fisheries Management workshop, and in the Queen Conch and Lobster Working Group meeting. This provided the opportunity to learn about the most current approaches for collecting fisheries-dependent information across the region. The inception report was produced during project phase I (Annex I). The KEs were also able to engage with representatives of countries about information needs, and the information related to availability of queen conch surveys, along with any other relevant information such as GIS layers, and habitat characteristics or fishing grounds within the area to be surveyed. The nine days following the departure of KEs focused on the preparation and delivery of the review document on fisheries independent approaches in the Caribbean context (Annex II), and the queen conch survey manual (Annex III). These documents were distributed to the Fisheries Managers and Officers by CRFM Secretariat for their review prior to the project phase II. SOFRECO drafted the interim technical report which presented in a formal way the 2 technical documents mentioned above.

Project Phase II was accomplished from August 4 to August 26 2013 beginning with introduction of all the participants including a review of their background knowledge, skills, and abilities (Annex IV.5). The KEs and participants met in St Vincent on 5 August and participants received training on conch biology, management, and conservation as well as work related to the preparation of the field activities. The PowerPoint presentations that were shown are included as Annex IV.3. Theoretical lessons and planning aspects were conducted over the first three days. Following the classroom activities, the group was mobilized by fast ferry to Union Island, where the mock survey was conducted.

Following this activity, the group transferred by fast ferry to Union Island to begin field training activities which included the mock survey (Final report of the mock survey: Annex IV.1). The mock survey included both SCUBA diving and towed-video sampling components. Dive safety was a primary concern in planning the scuba component of the activity (See Dive Safety Plan in Annex IV.2). Dive insurance was acquired for all divers. An additional training component consisted of plankton collections since the surveys were conducted during the reproductive season for conch.

After completion of these activities, the group returned to Kingstown for an additional 3 ½ days of classroom activities related to data entry, data analysis, GIS visualization, and report writing. Using the knowledge gained over the course of the program, each participant developed a strategy for sampling conch in their country (Annex IV.4). A closing ceremony and press conference was held at the SVG fisheries office. The press releases (Annex V) were distributed over regional email distribution lists.

As a result of the implementation of this project, country representatives learned about queen conch biology and ecology, GPS and GIS use, survey design, field work preparation, data collection from shallow waters (from the surface to 20m in depth) and deep waters (20-40m in depth), data entry, data analysis, report generation with management recommendations, safe-diving practices, and regional consideration for extending the queen conch survey in the Caribbean Forum ACP States. Final conclusions and considerations were developed regarding future queen conch surveys within the different countries.

Annex VI presents pictures from various activities accomplished during KEs first visit to St. Vincent and the Grenadines.

Complementarily, the KEs generated a project video-clip documenting the project outputs (Annex VII). Future plans are under development related to the publication of the results in scientific, peer-reviewed journals, and participation by students from the class in scientific meetings.

3. Comments on the Terms of Reference

During inception phase, the Key Experts team discussed the training implementation with the Regional Facilitation Unit (RFU) Coordinator of the ACP FISH II Programme, the CRFM and the Technical Team (TT); Field visits were carried out on the selected site for mock survey. Thus important comments rose on the terms of reference (ToR) and the following notations are to clarify important issues for the project implementation.

a) Based on the timeframe for the project, there is an increased risk of poor weather related to tropical systems. Indeed, the project implementation period falls during the hurricane season and the project may be impacted from tropical systems. Careful short-term programming and use of local weather forecasts will serve to minimize the potential risks. Furthermore, poor weather can be addressed by moving some field activities into areas that are more protected on an ad hoc basis. In the event of case of force majeure, training implementation may be impacted notably through travel interruptions/delays of the participant to/from the training which may result in temporary suspension of training delivery and/or delays which may have some financial consequences.

b) After consultations with the Technical Team, it was agreed that the workshop would function best if it was split between Kingstown, St. Vincent and Union Island/Tobago Cays. The classroom portion of the workshop will be in Kingstown at the CRFM office and the field work will be in Union Island. The reasons for this were to address logistical difficulties related to facilities, internet connectivity required for training, and communications requirements define in the ToR for the project. Extending the training in Kingstown provides an opportunity to invite three additional participants (resource managers) specifically for classroom lectures and practices.

c) The ToR suggest that one technical/scientific officer from the CRFM Secretariat would participant in all workshop sessions and assist countries during field surveys. There is a high likelihood that CRFM will not have a technical/scientific diver available. Therefore, we suggest that the following possibility should be considered if necessary: If a technical/scientific officer from the CRFM Secretariat is not available, CRFM or their designee may select a participant that meets the technical expertise and experience as per the project requirements (e.g., diving certified) from either local or other locations including but not limited to an additional fisheries officer, a park manager, or a fisher.

d) The indicative outline of training presented in the ToR was basically followed for the Training of Trainers scheduling. It was slightly tailored though to adapt to logistical and technical considerations of training delivery. For instance, the first 3 days will be dedicated to lectures and courses rather than 2 days due to logistics constraints associated with ferry service to Union Island and the timing of the Sunday day off.

e) Given the capacity of the available vessels in Union Island, the practical training session for mock survey will require 2 sea-worthy vessels with a total capacity for all vessels to hold 12 trainees and the KE team.

f) To guarantee the efficient diving operations, the Dive Guide shall function as a dive master and will be responsible for ensuring safe diving operations from onboard the vessels including monitoring bottom times and ensuring sufficient surface intervals as required for safe diving practices.

g) Due to scheduling constraints of participants and beneficiaries from 10 countries and the CRFM, the inception mission commencement date for this assignment was 2 June 2013 and the intended implementation of the field training activities will be from 6 August 2013. The time between the 2 missions was also constrained by the necessary administrative procedures that have to be completed in some countries to enable their fisheries officers to travel for such regional events.

Hence an invitation letter and an information note have been drafted jointly with the CRFM which will send them to the fisheries administration of each country shortly to guarantee the attendance of one representative by involved country to the workshop.

h) Communication and project visibility: The TT, KE team and ACP FISH II representative agreed on having one press event with government representatives and the local media at the end of the training session instead of at the beginning as stated in the ToR. This proposal from CRFM was accepted considering there will be more results to present, experiences to share and overall conclusions and recommendations to communicate at the end of the Training. A press-release will be prepared at this time too.

i) The following further considerations have been considered as critical to the development of the project :

a. Dive insurance to ensure safe-diving operations. The project made sure that each participant was provided with an insurance

b. Renting equipment to conduct surveys such as towed-video systems for deepwater surveys has been proven necessary. The renting services should include assistance to set up and monitor the use of the underwater video systems.

c. Additional training either before or after the Phase 2 may be provided to ensure that participants are prepared for the activities or to develop additional capacity.

d. Proper organization of activities in St. Vincent and/or Union Island was critical to ensure the project success and efficiency, in particular for the event logistics and coordination.

Comments made during and after the project are included in section 5 – Conclusions and Recommendations

4. Organization and Methodology

4.1 Delivery of Terms of Reference (table as below)

	Terms of reference (each of the key activities from the ToR)	How delivered through the assignment (has it been done? Or how has it been met)
Phase 1 Activities		
1	Briefing in St. Vincent and the Grenadines with the ACP Fish II Programme and the CRFM Technical Officers, to review Terms of Reference and agree on detailed project work plan.	Done by KE1 and KE2 in St. Vincent in conjunction with Sandra Grant Regional Manager of the ACP Fish II Programme, Susan Singh-Renton from CRFM and Jennifer Cruickshank-Howard from the Fisheries Department in St. Vincent and the Grenadines. The meeting took place in June 3, 2013.
2	Consult and collaborate with the CRFM Secretariat during the execution of this consultancy for accessing key background documents and ensuring a holistic and integrated approach to queen conch assessment and management activities in the region.	This activity was conducted for the most part during the initial meetings in St. Vincent and the Grenadines, the participation of the KEs in the regional validation workshop of the ACP Fish II project entitled "*Support to improve and harmonize the scientific approaches required to inform sustainable management of queen conch (Strombus gigas) by CARIFORUM States*". Technical documents were obtained or requested when otherwise unavailable.
3	With the support of the CRFM Secretariat, identify, collect and review national, regional and international documentation and information related to queen conch assessment and management.	The CFRM Secretariat invited the KEs to attend the queen conch and lobster working group meeting that took place from June 10-14, 2013, which facilitated the exchange of information and additional documents for several countries.
4	Conduct a critical evaluation of use of fisheries independent approaches (with emphasis on under water visual survey methods) for assessment of queen conch status in the Caribbean and prepare a detailed report	This report was completed by conducting a detailed review of over 100 documents. The review examined the use of underwater visual techniques and subdivided the approaches by type of survey and country. The document was delivered last July 12, 2013, and comments were received during the following month. The final document integrated aspects on density and habitat as recommended (see Annex II).
5	Consult with key stakeholders including: government ministries and departments, fishermen organizations/cooperatives, stakeholders, NGOs, research institutions, private sector (as identified by the CRFM Secretariat and Member States).	Process was accomplished along with activity 3. Informal meetings was held with local fishers on Union Island as part of Phase 1 sampling planning. No visits for additional countries were expected to take place in the implementation of this project.
6	Prepare a draft training manual on underwater visual survey methods in the Caribbean for discussion with CRFM Secretariat.	A manual was prepared detailing core basic concepts on biology, survey methodologies, Geographic Information Systems and the use of Global Positioning System, statistical analyses, and quota development. Comments received at the end of August were attended in the

	Terms of reference (each of the key activities from the ToR)	How delivered through the assignment (has it been done? Or how has it been met)
		document final version (see Annex III).
Phase 2 Activities		
7	Organize, convene and facilitate a Regional Training Workshop on Underwater Visual Survey Methods in St. Vincent and the Grenadines (17 full working days, indicative number of participants is 12) that includes both theoretical and practical sessions for addressing survey design, implementation, data recording, analysis and reporting	The SOFRECO team (Guillaume Romain, Sherill Barnwell, Martha Prada and Robert Glazer among others) were successful in convening a total of 16 participants from 10 countries (see Annex IV) and took care of the logistics concerning their travel, accommodation, local transportation, classroom setting, dive operations, underwater video rental, class preparation, lectures, webinars, supplemental materials, etc). KEs also drafted invitation letters along with an information note detailing the training contents and specific requirements, which were sent to the relevant fisheries administrations of the 10 countries by the CRFM. Training was based at the CRFM office in Kingstown, SVG and at Kings Landing Hotel in Union Island. A total of 51 locations were surveyed by diving and additional 29 were explored with the underwater video system (Annex IV.1). The training was held during August 6-24, 2013 (17 full working days), and additional working days were necessary for the KE and event coordinator for class preparation and to attend to project logistics. All aspects of the training stated in the Terms of Reference were accomplished, and additional aspects such as plankton sampling, development of a project video, and participation in international forum presenting project results will also be available once the project is completely finalized.
8	Assist in the preparation of a Press-Release and presentation at a media coverage of the project activity	Two press releases were prepared (see Annex V). The first was prepared at the beginning of the assignment, and the second at the completion of the project. A meeting with the local media was organized and conducted at the Fisheries Department in SVG on 23 August 2013. Press releases were distributed regionally using email distribution lists with widespread circulation (e.g., gcfinet). In order to keep communication during the field activities, daily communications notes were written (Annex V).
9	Prepare and submit Interim and Final Technical Reports including photographic record of the assignment when required	An interim technical report was prepared and submitted in July, 2013 (Annex I). The present document comprises the Final Technical Report. The technical report consists of a main document and complementarily project and/or technical documents in annexes.

4.2 Conduct and details of the assignment

4.2.1 Phase I – St. Vincent and Union Island

First Input: 2 June 2013 – 12 June 2013 – The Research & Consultation Phase

Approach to the Assignment

The Research and Consultation phase of the project focused on accumulating the most current background information on the status of queen conch fisheries independent assessments and how they are used to develop management strategies. Specifically, the KEs attended the Regional Validation Queen Conch Fisheries Management workshop, and in the Queen Conch and Lobster Working Group meeting in St. Vincent. A number of consultations were held with representatives attending these workshops.

The following consultations were held with the participants at the workshop.

Consultations for the Assignment – Phase I		
Date	Person	Country
4 June 2013	Kim Baldwin	Barbados
6 June 2013	Richard Appeldoorn	Region wide
6 June 2013	Crafton Isaacs	Grenada
7 June 2013	Karl Aiken	Jamaica
8 June 2013	Lester Gittens	The Bahamas
10 June 2013	Ricardo Morris	Jamaica
10 June 2013	Hazel Oxenford	Barbados
11 June 2013	Allena Joseph	St. Lucia
11 June 2013	Mauro Gongora	Belize
12 June 2013	Shawn Isles	St. Kitts and Nevis
11-17 June 2013	Paul Medley and Monica Valle	KEs for ACP Fish II Programme (Project ref. N°: CAR/3.2/B.15)
12-14 June 2013	Susan Singh-Renton	CRFM Secretariat

The background information that was identified in these discussions was combined with subsequent direct correspondence with researchers and managers, and a thorough literature search. Additional information was provided from the KEs personal libraries. Together, they served as the basis for the preparation of the two documents that were developed as part of this phase of the project: 1) a Queen Conch Manual for Fisheries Independent Sampling, and 2) Review of Underwater Fisheries Independent Approaches Used for Queen Conch Population Estimation.

Prior to the project second phase, the KEs contacted the trainees and provided them the detailed agenda (Table 1) of the training, the checklist of items to bring, and the conch survey manual.

Tabe 1. Detailed agenda of the project Phase 2 provided to the training participants.

Day	Date	Activity	Time	Description	Contents	Responsible	Duration (hours)	Preparation
1	5-Aug	Travel	Whole day	Arriving SVG				
2	6-Aug	session 1	Morning	Queen conch biology/ecology	Life cycle	MP	1	PPT + video
					Adult reproduction	BG	1	PPT
					Early life/Growth	BG/MP	1	PPT
		Coffee						
		session 2			Conservation policies	MP	1	PPT, video
					Diseases/parasites	BG/MP	1	PPT
		Lunch						
		Class session 3	Afternoon	UVC alternatives/needs	Population concepts & dynamics	BG	0.5	PPT
					Conch sampling and statistical issues	BG/MP	0.5	PPT
					Population and aggregation shallow water surveys	BG/MP	0.5	PPT
					Review of the underwater methods in the Caribbean	BG	0.5	PPT
		Coffee						
		session 4			Deep water technologies (diving, ROV, AUV, acoustics)	MN/MP	1.5	PPT + Webinar 1
					Round table - internet search		1.5	PPT
3	7-Aug	session 5	Morning	GPS/GIS concepts and needs	GPS concepts	MP/GR	1	Webinar 2
					GIS concepts	MP/GR	1	Webinar 3
					GPS exercises	MP/GR	1	Working with personal computers
		Coffee						

		Class session 6			GIS exercises	MP/GR	1	Working with personal computers
					GIS Software	GR	1	Webinar 4
		Lunch						
		session 7	Afternoon	Mapping exercises	Mapping exercises	MP	2	Working with personal computers
				Coffee break				
				Mapping exercises	Mapping exercises	MP	2	Working with personal computers
4	8-Aug	session 8	Morning	Survey design/ safety considerations	SVG mock survey considerations	MP/BG	1	PPT
					Habitat mapping/depth strata-country with exercises	MP	2	Working with personal computers
		Coffee						
		session 9		Country details		participants	3	PPT participants
		Lunch						
		session 10	Afternoon	Field work preparation	Station definition, GPS upload, sampling tools,	MP/BG	PPT	
					Review diving safety	MP/BG		PPT + Internet search
					Data storage strategy	MP/BG	PPT	
		Coffee						
		session 11		Conclusions and recommendations	Group discussion, final recommendations			
5	9-Aug	Travel	Morning	Fast ferry to Union Island				
		Lunch						
		Dive check	Afternoon	Participant dive check	Grenadines dive/MP/BG			
6	10-Aug	Diving	Whole day	goal a total of 12 stations sampled	Grenadines dive/MP/BG			
7	11-Aug	OFF						

8	12-Aug	Diving	Whole day	goal a total of 12 stations sampled	Grenadines dive/MP/BG		
9	13-Aug	Diving	Whole day	goal a total of 12 stations sampled	Grenadines dive/MP/BG		
10	14-Aug	Diving	Whole day	goal a total of 12 stations sampled	Grenadines dive/MP/BG		
11	15-Aug	Diving	Whole day	goal a total of 12 stations sampled	Grenadines dive/MP/BG		
12	16-Aug	Diving	Whole day	goal a total of 12 stations sampled	Grenadines dive/MP/BG		
13	17-Aug	Diving	Whole day	goal a total of 12 stations sampled	Grenadines dive/MP/BG		
14	18-Aug	OFF					
15	19-Aug	Video survey	Whole day	Deep sites video survey goal 20 stations	KB/MP/BG		
16	20-Aug	Video survey	Whole day	Deep sites video survey goal 20 stations	KB/MP/BG		
17	21-Aug	Travel	Morning	Fast ferry to St. Vincent Island			
			Afternoon	Data quality verification		MP/BG	
18	22-Aug	session 11	Whole day	Data analysis: biomass estimations steps GIS products		MP/BG	Working with personal computers
19	23-Aug	session 13	Whole day	Data analysis continuation Quota estimation & field work report		MP/BG	Working with personal computers
20	24-Aug	session 14	Whole day	General analysis & discussion		MP/BG	

			Country-specific sampling plans Final considerations Press event	MP/BG CRFM/MP/BG	Working with personal computers
21	25-Aug	Travel	Departure of participants		

Second Input: June 2013 – The Development of the Review of underwater fisheries independent approaches for queen conch population estimations

A review of the past efforts for assessing queen conch populations using Fisheries Independent approaches was conducted and completed in accordance with the Terms of Reference. Over 100 documents were reviewed and cited in the report. The document was organized by methodology and updated to respond to received reviews, in particular related to the inclusion of details about the survey objective either by addressing examination of the species abundance/density or habitat assessments (Figure 1). The final revision is included as Annex II.

Third Input: June 2013 – The Development of the Queen Conch Survey Manual

The queen conch Survey Manual was prepared using information gleaned from expert consultations, publications and reports, and the Key Experts' experiences. The Survey Manual contains five chapters, developing different issues related to queen conch biological and ecological concepts;, the most currently available techniques and methods utilized to estimate queen conch abundance, from the planning through data analysis; complementary information to support ecosystem based management approaches; and the description of survey planning and tips. The manual is accompanied by a list of references. The manual was sent to the project members prior to the second phase for information, and their critical review. The final version introduced an additional chapter with practical recommendations and in depth description of the data analysis proposed. Each chapter was complemented with the addition of the training objectives, and improvements of some of the figures. The manual was written in a descriptive manner, avoiding technical terminology when appropriate, and in other cases defining technical terms, and illustrated with 17 figures, 4 tables and 1 annex. The final version of the Queen Conch Survey Manual is presented in Annex III.

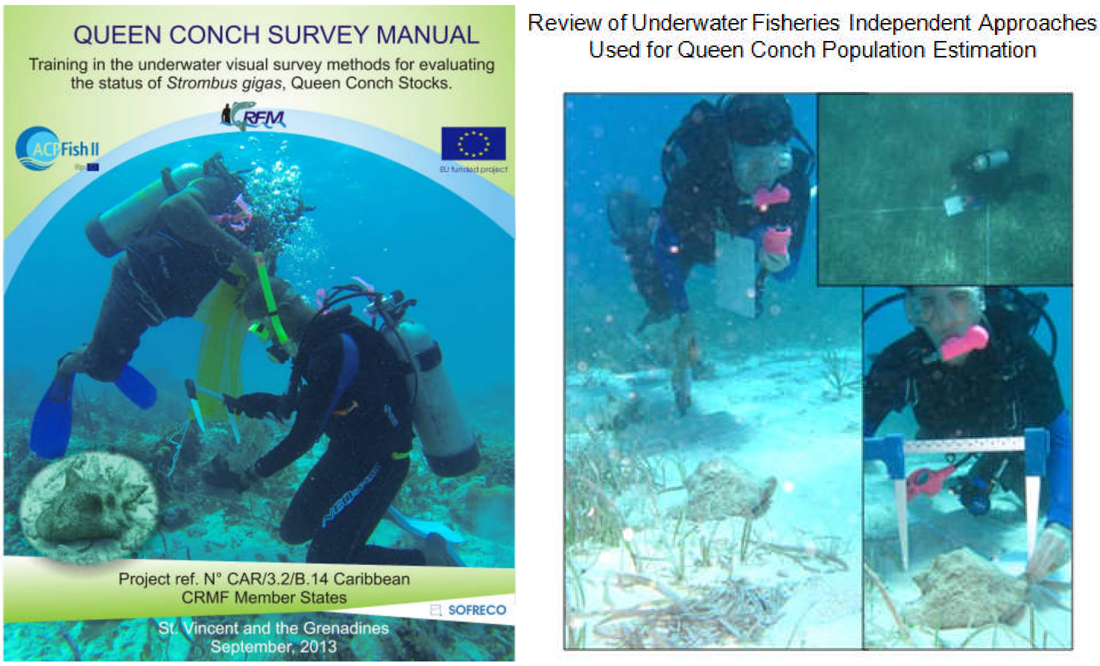


Figure 1. Front pages of project second and third outputs.

4.2.2 Phase II – St. Vincent and Union Island

Fourth Input: 6 August 2013 – 8 August 2013 – Stage 1 - The Classroom Activities providing background information

Starting on Tuesday, 6 August, the training group met in the offices of the CRFM in Kingstown, SVG for the initial classroom activities. The conference tables were arranged in a horseshoe configuration with enough computer connections to facilitate efficient and informal interactions as well as providing a friendly configuration for viewing the numerous presentations. Wireless internet capabilities were provided by CRFM. A projector was donated by the Gulf and Caribbean Fisheries Institute (GCFI) for Microsoft Powerpoint and other visual presentations. A good amplification sound system was provided during all classroom activities.

AdobeConnect webinar software was provided at no cost by the GCFI. Table 2 describes the content of the classroom activities.

	6 August 2013	
Title	Type of Activity	Who involved
Introduction to the Project	Informal welcome	S. Singh-Renton
Queen conch biology and ecology	PowerPoint presentation	M. Prada
Queen conch conservation	PowerPoint presentation and documentary video.	M. Prada
Reproductive issues with queen conch	PowerPoint presentation	R. Glazer
Review of ROV and AUVs for deepwater sampling	Internet Search	Group activity
Class overview and evaluation	Informal day summary	Individual trainee

	7 August 2013	
Introduction to Free GIS and GPS concepts and software	Interactive webinar accompanied by PowerPoint presentations and class exercises over the internet via AdobeConnect.	Download, installation and general tools available in Quantum GIS and DNR Garmin software. Session presented by Gerardo Rios and supported by Martha Prada.
	GIS classroom activities	Group activity
Deep-diving Methodologies	PowerPoint presented over the internet via AdobeConnect	Michael Nemeth
	8 August 2013	
Connectivity in queen conch populations	PowerPoint	R. Glazer
Safe Diving Practices	PowerPoint	R. Glazer
Union Island Sampling Design	Classroom activity	Group activity
19 August 2013 (at Union Island)		
Review of Fisheries Independent sampling methods and analyses used in Florida with an emphasis on sample size determination	Powerpoint	R. Glazer

Table 2. Activities during Phase 2/Stage 1 of the ACP Fish II project Training in Underwater Visual Survey Methods for Evaluating the Status of *Strombus gigas*, Queen Conch Stocks Conducted in SVG from 6-8 August 2013.

Fifth Input: 9 August 2013 – 21 August 2013 – The Field Activities and Mock Survey

After transferring to Union Island via the fast ferry, the afternoon of 8 August was devoted to working with the dive contractor to distribute equipment to the trainees and dive check-outs. The group met in the evening to go over the planning of the surveys.

On 10 August, the field work began. The dive teams were divided into two vessels. Vessel one, which was the large vessel, contained 3 teams of two individuals and Vessel two contained two teams of two divers. As planned, maximum of two dives per day were conducted by each dive team. Each day, one of the trainees was assigned the role of communications officer and this individual prepared a record of the daily activities, which contained images with GPS tracks, stations visited, photographs and relevant observations. Field communication notes were then distributed by email (Annex V). A total of 51 sites were sampled by diving, during seven days (August-17). The diving was conducted using safe-diving protocols following the guidelines detailed in the Dive Safety Manual (Annex IV.2).

Each evening, the divers were instructed to input their data into an Excel spreadsheet template designed for these surveys. The communications officer was also required to submit their reports so that the members of the Technical Team could be updated on a daily basis.

Additionally, each evening a country report was presented to the entire group explaining the status of surveys in the countries that were represented. This presentation also included a briefing about plans for future surveys. The group was encouraged to ask questions so that they could apply the lessons learned to their specific location.

To explore the queen conch deeper stocks (25-40m), participants had the opportunity to use a towed underwater video system during two days (19-20 August, 2013). Dr. Kimberly Baldwin from the University of the West Indies, Cave Hill (Barbados) was contracted to provide the video services since she had developed a survey approach using towed cameras and she was in charge of the equipment. On Sunday 18 August,2013, participants met with Dr. Baldwin to review the approaches used for towed-camera sampling. The following day, the group was divided so that she could efficiently demonstrate the technique to a manageable small group of trainees. A total of 29 transects were visited with this video system. Results from the entire field work is included as Annex IV.1.

Sixth Input: 22 August 2013 – 24 August 2013 – The Data Analyses, Recommendations, and Press Event

The last section of the training convened again at the CRFM offices in Kingstown, SVG. The activities focused on a review of the data including the importance of identifying errors, proofreading the data, data processing, and data backup needs. Trainees were instructed on utilizing several data processing tools in Microsoft Excel® and learned more approaches using Quantum GIS in the generation of thematic maps and to better illustrate survey results. The use of GPS, including the downloading and uploading of data from/to the GPS unit was reinforced through practical exercises. Group discussions and analysis were developed once preliminary results from the mock survey were obtained. A Powerpoint presentation summarizing the project results was generated for the closing ceremony and press event with the local media.

For the closing ceremony, certificates were prepared and given to each of the participants. These certificates clearly stated the degree of participation in the intense training provided (i.e., classroom only or classroom and field activities, dive support, etc). An example of a Certificate is presented in Figure 2.


Certificate of Completion

THIS ACKNOWLEDGES THAT

Kris Isaacs

HAS SUCCESSFULLY COMPLETED THREE-WEEK CLASSROOM AND FIELD ACTIVITES ASSOCIATED WITH THE 2013

TRAINING IN UNDERWATER VISUAL SURVEY METHODS FOR EVALUATING THE STATUS OF STROMBUS GIGAS, QUEEN CONCH STOCKS

SANDRA GRANT
REGIONAL MANAGER
ACP FISH II PROGRAMME

Date

SUSAN SINGH-RENTON
DEPUTY EXECUTIVE DIRECTOR
CRFM SECRETARIAT

Date

CRFM SOFRECO

Figure 2. Example of the certificates given to the project participants upon completion of the training.

Communication and Visibility:

A press event was organized to conclude the training workshop and present the mock survey findings. 2 Press releases were dispatched (one for the project kick off) and banners were developed and installed according to EU guidelines.

In addition, a video clip of the training workshop has been developed on basis of video caught by the KE team.

The video is available on the following link: http://youtu.be/eGDOtl9KGTY

5. Conclusions and Recommendations

Comments on the Assignment and Lessons Learned:

- **The classroom activities associated with background presentations**

  The utilization of various educational technologies and tools (e.g., webinar software, PowerPoint, internet videos, personal videos) along with a good sound amplification system contributed to better learning experience for the trainees. The mix of approaches also served to maintain the attention of the group during some long and rigorous days. Some difficulties were experienced during the webinar sessions related to 1) connectivity on the presenter's side in Mexico, and 2) having the software already downloaded on the participants' computers. With regards to the first issue, tests were conducted in days prior to the class in which potential connectivity issues were identified and thought to be resolved. This issue will likely be overcome as advanced technology is made more available throughout the region. Of note is that a second webinar conducted from Puerto Rico did not have these connectivity issues; the video and audio were clear and without any issues. With regards to the second issues, this may be improved in part by dedicating additional time for downloading of the appropriated software either within the program or prior to arriving for the training. The availability of having a fast internet connection was considered a plus in the project.

- Personalized training utilizing computers/GPS requires more than one trainer to attend to difficulties related to variability in machine capabilities, security and networking issues, different operating systems, and different trainees skills.

- For future classrooms, it might be necessary to have access to a wet laboratory thus allowing participants to learn about the queen conch anatomy and other basic biological characteristics. Despite the fact that plankton samples were collected, it was not possible to examine them due to the lack of access to a wet laboratory.

- Country participants were selected late in the schedule; thus, in many cases they did not have enough time to read technical documents in advance as was needed for a more productive classroom analysis and discussion. Because conducting underwater visual census programs requires a team of persons with different expertise, it is recommended for future training to consider the participation of more than one trainee per country, and to increase participation by fishers (at least for the field work, examination of the video surveys, and data processing).

- Accordingly to the participants' evaluations, and the KEs' opinion, , it is recommended in future training projects to dedicate more time to survey design and data analysis, and less time to in water training. While it is understood that an important component of this training was a complete mock survey, the partitioning of time between field and classroom activities should be carefully considered when developing future trainings because a great deal of time is required to complete both objectives.

- Working time allocated for the KEs to prepare classroom activities was insufficient

- Considering the immense advantages of using free GIS and GPS software, and the limited time allocated for its use, the participants agreed to the need for more specific training on these aspects since they have the potential for broader use in overall fishery management programs and the application of conservation policies. Consequently such training should be made widely available to CARIFORUM Member States.
- Microsoft Excel® has multiple options to facilitate data management and processing; some of them were taught in this training. Definitely additional training in the use of this software would significantly facilitate the efficient work of fisheries managers since their activities require extensive mathematical and statistical analysis and, therefore, skills.

The mock survey

- The training used only ambient air in the SCUBA tanks for diving. However, rigorous diving over numerous days using air is exhausting. Enriched Air NITROX (NITROX) is becoming more common throughout the region and using this for SCUBA fills significantly reduces the effects of prolonged diving. The KEs recommend that future trainings and surveys use NITROX. The use of NITROX does not require special dive gear, but it does need special compressors, training, and certifications with consequent cost implications.
- The accessibility of the internet connection and the integration of local knowledge about weather conditions and site characteristics proved essential to successfully conducting this project and to completing the daily communication notes. It is recommended that future underwater surveys make appropriate consideration related to facilitating communications with respect to the local characteristics and resources.
- To compensate for variable data quality associated with differences between observers, it is recommended to add one day for a practical training in the underwater visual census methods, prior to the actual data collection. Practices on this aspect were conducted in the training, but only on land, since KE were trying to maximize the SCUBA surveys to add to the validity of the mock survey.
- The participants were generally of the opinion that after only two or three days, they had sufficient training in the underwater techniques, it is recognized that having several days of diving provided an opportunity to compensate for undesirable weather conditions and to demonstrate the need to be physically fit for real country surveys which usually last several weeks.
- Our experience with the deep water towed-camera system suggests that this technique needs modifications to be used reliably. For example, deficiencies with the camera stability, the angle at which the lenses were fixed, the camera resolution, and electrical interference all contribute to difficulties associate with the quality of the video-imagery. However, it is reasonable to expect that the technique is close to being sufficiently well-developed to employ it regionally. There is hope that work in Florida will result in broad applicability with a minimal amount of experimentation and engineering.
- The work in exposed and deep water marine environments is challenging and technology is rapidly evolving. It is recommended in future projects to include time and resources for better exploration of benefits and disadvantages of various systems currently available. The sustainability of the queen conch fishery nowadays

heavily relies on the existence of, and reproduction within, deep-water stocks. Time dedicated to examine the appropriate system/strategy to gather these data should be a priority.

- There are methods that are much more robust and easy to use for deep-water surveys such as autonomous underwater vehicles (AUVs), Remotely Operated Vehicles (ROVs), and mixed-gas diving. However, these methods are expensive and therefore have limited widespread applicability. In the case of mixed-gas diving, extensive specialized training is required and may be beyond the capacity and/or financial wherewithal of many small island countries. The availability of equipment and trained personnel in Puerto Rico and other Caribbean islands open a door for the use of these innovative methods either for training or on a contractual basis.
- During the field work activities, some participants required a visit to the local doctor. As a consequence, they were not able to participate in the diving activities as planned. Fortunately, there were always enough divers to make the necessary adjustments, without jeopardizing the overall objectives. It is recommended to include training in first aid with attention to common accidents (different than diving). This will be particularly useful should accidents occur when countries are conducting their own surveys.
- The importance of collecting additional information while doing an underwater census was emphasized, but the project timetable did not allow the completion of any additional data collection. For instance, it was not possible to investigate length-weight relationships, integrate additional morphometric considerations from conch photographs, or integration of plankton results to examine the source of local conch stocks and corroborate successful reproduction. All these aspects still need to be addressed in future field activities.
- The collection of plankton samples is recommended as an easy monitoring program that can be implemented in the future. Appropriate plankton nets can have 202 micron mesh, and tows may last 15 minutes or more depending on the size of the plankton net and the local ocean productivity. Studies on the plankton community may provide a lot of information on various fisheries stocks and as such training is recommended in this area.

Considering individual country limitations with respect to survey capacity (e.g., accessibility to appropriate dive operations, logistical difficulties, trained/skilled personnel) it is highly recommended that the project participants serve as a core team for assistance to other countries in the region to conduct region-wide censuses. Accordingly, an international, inter-disciplinary working group should be developed that can share existing resources thus contributing to the efficient collection of data necessary to contribute to ecosystem-based management and integration of sustainability criteria.

The survey team

There was a wide range of capacity coming into this training with respect to the background of the participants. These could be characterized in the following categories:

- The authority/capacity of the participants to implement programs in their countries upon their return. In some cases, the individual who will be prioritizing and implementing the programs was present. In other cases, the person participating in the course was likely not the most appropriate representative from the country. In one case, the individual did not know why he was there with respect to both his specific job responsibilities, and secondarily, to his country's priorities. Before the training was completed, he received clarification from his supervisor.

- The relevance of the training for specific countries. There was a wide range of needs on a country-by-country basis. For example, the representatives from Jamaica and Belize already have well-developed fisheries-independent queen conch survey programs, however they learned new skills in the data analysis, GIS/GPS tools, increasing their overall understanding.
- The implementation of country-specific underwater censuses suffers in many cases from a lack of background information related to habitat maps and detailed bathymetry. Obtaining this information will be important prior to conducting actual country surveys.
- The group agreed to the need of receiving training, and development of a strategy, that would allow the generation of benthic mapping at the appropriate scale (detailed, 100% coverage, including deep waters) to understand queen conch spatial distribution and abundance.

Additional Recommendations

More recommendations are provided in the supporting technical documents presented as annexes in this report, especially in the mock survey report.

6. Project Evaluation

The comments and overall evaluation made by the project participants are presented in this section and as Table 3.

In general they expressed how they enjoyed the workshop, and expected this to be beginning of a continued survey program. They acknowledged that this project was useful, well-organized, and demanding but well worth the effort. In particular, they expressed that data phase was awesome and asked for more time for practical exercises including GIS/GPS aspects. In general, they reported that the activities were very informative, interesting, and educational, with the presentations well-prepared and the results understood.

There were complaints about not having separate rooms while in Union Island, but those comments were not shared by the majority of the group. There were also complaints about insufficient time to discuss technologies to sample in deep water environments.

The majority believe that now they have the skills to effectively lead others and feel comfortable to conduct this exercise in their country. They recognized that more research strengthening skills are necessary for the region. They expressed their desire to conduct this project in other countries.

Table 3. Overall project evaluation from the training participants.

Phase	Aspect	Question/Response	Excellent	Good	poor
Phase I	Venue	How adequate was the venue for the workshop?	8	7	
	Agenda	How appropriated was the time allocated to the workshop?	2	12	1
		How was the time allocated to each session?	1	14	
		Did you manage to voice your feedback/concerns?	6	9	
		Did you receive supplemental technical reports with sufficient advance	5	10	
		How was the overall organization of the event (travel/accommodation/venue)?	6	9	
	Content	Was the workshop appropriated to fulfill project objectives?	5	10	
		Were the contents of the presentations and discussions useful?	4	11	
		Was planning and preparation of the survey adequate?	7	7	1
		Did you learn/complement your knowledge about queen conch underwater visual census?	6	9	

Annexes

Annex I: Inception Report

Annex II: Review of Underwater Fisheries Independent Approaches for Queen Conch Population Estimations

Annex III: Queen Conch Survey Manual

Annex IV: Reports from the training workshop held in Kingston and Union Island, Saint Vincent and the Grenadines, from August 6th to 24th 2013

Annex IV.1: Mock Survey Report and Recommendations

Annex IV.2: Mock Survey Dive Safety Plan

Annex IV.3: List of Presentations Given During Classroom Activities

Annex IV.4: Countries-Specific Plans for Queen Conch Fisheries Independent Surveys developed during classroom activities

Annex IV.5: Trainees Contact Information and Short Biographies

Annex V: Project Communication Releases

Annex VI: Project Photographs

Annex VII: Project Video-clip

Annex VIII: Terms of Reference

Annex I: Inception Report

"Strengthening Fisheries Management
in ACP Countries"

Inception Report

TRAINING IN UNDERWATER VISUAL SURVEY METHODS FOR EVALUATING THE STATUS OF *STROMBUS GIGAS*, QUEEN CONCH STOCKS

Project ref. N° CAR/3.2/B.14

Region: Caribbean – CRFM member states
Country: Si. Vincent & the Grenadines

Date: June 11, 2013

Assignment by:

Project Funded by the European Union

Table of Content

1. Short Background

The queen conch, *Strombus gigas*, is a species traditionally fished since pre-Colombian times and is valued as a source of food, jewellery and other cultural values. Within the CARICOM/CARIFORUM region, the queen conch is commercially exploited with an estimated landing of about 60 million USD (CTE), and represents a significant source of income to fishers, generates jobs for the processing and marketing, ornamental, tourist, and restaurant industries in the region across the entire Caribbean region. Due to an overall reduction of its natural populations across its distribution range, it was included in Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) in 1992.

Currently the amount and quality of available fishery-dependent data do not allow for many countries to conduct full stock assessments of the species, thus fishery-independent data is being considered a promising alternative to evaluate conch stocks while at the same time allowing the gathering of additional relevant information needed to establish reference points towards more sustainable queen conch fisheries and to improve the resource based on ecosystem-based management principles. In response to this need, a Training of Trainers course will be developed as the basis of this project and will include participants from 10 out of the 15 CARIFORUM states.

This project is being implemented by the consulting firm Société Française de Réalisation d'Études et de Conseil (SOFRECO) with support from the Caribbean Regional Fisheries Mechanism (CRFM) Secretariat. The two Key Experts (KEs) from SOFRECO are Dr. Martha Prada and Robert Glazer. The overall objective is to build the capacity of fisheries officers and others with similar responsibilities in the target group in using underwater visual survey methods for the management of *Strombus gigas*, queen conch. It is expected that participants will learn in detail how to use fisheries independent approaches for assessment of queen conch by participating in field work and conducting data analysis. They will be provided with a training manual on underwater visual survey for shallow and deep water queen conch populations developed by the KEs and will thus be able to apply ecosystem-based fisheries management principles to their local stocks.

2. Comments on Terms of Reference

During inception phase, the Key Experts team discussed the training implementation with the Regional Facilitation Unit (RFU) Coordinator of the ACP FISH II Programme, the CRFM and the Technical Team (TT); Field visits were carried out on the selected site for mock survey. Thus important comments rose on the terms of reference (ToR) and the following notations are to clarify important issues for the project implementation.

a) Based on the timeframe for the project, there is an increased risk of poor weather related to tropical systems. Indeed, the project implementation period falls during the hurricane season and the project may be impacted from tropical systems. Careful short-term programming and use of local weather forecasts will serve to minimize the potential risks. Furthermore, poor weather can be addressed by moving some field activities into areas that are more protected on an ad hoc basis. In the event of case of force majeure, training implementation may be impacted notably through travel interruptions/delays of the participant to/from the training which may result in temporary suspension of training delivery and/or delays which may have some financial consequences.

b) After consultations with the Technical Team, it was agreed that the workshop would function best if it was split between Kingstown, St. Vincent and Union Island/Tobago Cays. The classroom portion of the workshop will be in Kingstown at the CRFM office and the field work will be in Union Island. The reasons for this were to address logistical difficulties related to facilities, internet connectivity required for training, and communications requirements define in the ToR for the project. Extending the training in Kingstown provides an opportunity to invite three additional participants (resource managers) specifically for classroom lectures and practices.

c) The ToR suggest that one technical/scientific officer from the CRFM Secretariat would participant in all workshop sessions and assist countries during field surveys. There is a high likelihood that CRFM will not have a technical/scientific diver available. Therefore, we suggest that the following possibility should be considered if necessary: If a technical/scientific officer from the CRFM Secretariat is not available, CRFM or their designee may select a participant that meets their priorities and the project requirements (e.g., diving certified) from either local or other locations including but not limited to an additional fisheries officer, a park manager, or a fisher.

d) The indicative outline of training presented in the ToR was basically followed for the Training of Trainers scheduling. It was slightly tailored though to adapt to logistical and technical considerations of training delivery. For instance, the first 3 days will be dedicated to lectures and courses rather than 2 days due to logistics constraints associated with ferry service to Union Island and the timing of the Sunday day off.

e) Given the capacity of the available vessels in Union Island, the practical training session for mock survey will require 2 sea-worthy vessels with a total capacity for all vessels to hold 12 trainees and the KE team.

f) To guarantee the efficient diving operations, the Dive Guide shall function as a dive master and will be responsible for ensuring safe diving operations from onboard the vessels including monitoring bottom times and ensuring sufficient surface intervals as required for safe diving practices.

g) Due to scheduling constraints of participants and beneficiaries from 10 countries and the CRFM, the inception mission commencement date for this assignment was 2 June 2013 and the intended implementation of the field training activities will be from 6 August 2013. The time between the 2 missions was also constrained by the necessary administrative procedures that have to be completed in some countries to enable their fisheries officers to travel for such regional events.

Hence an invitation letter and an information note have been drafted jointly with the CRFM who will send them to the fisheries administration of each country shortly to guarantee the attendance of one representative by involved country to the workshop.

h) Communication and project visibility: The TT, KE team and ACP FISH II representative agreed on having one press event with government representatives and the local media at the end of the training session instead of at the beginning as stated in the ToR. This proposal from CRFM was accepted considering there will be more results to present, experiences to share and overall conclusions and recommendations to communicate at the end of the Training. A press-release will be prepared at this time too.

i) The following further considerations will be critical to the development of the project :

   a. Dive insurance to ensure safe-diving operations. This will be supplied by the dive operator in charge of the diving activities organization.

   b. In some cases, it may be necessary to rent equipment to conduct surveys such as towed-video systems for deepwater surveys. The renting services should include assistance to set up and monitor the use of the underwater video systems.

   c. Additional training either before or after the Phase 2 may be provided to ensure that participants are prepared for the activities or to develop additional capacity.

   d. Proper organization of activities in St. Vincent and/or Union Island will be critical to ensure the project is successful and efficient, in particular for the event logistics and coordination.

3. Approach to the assignment

The project will be developed in two phases (see Annex I – presentation at assessment workshop). The first is being conducted between June 1-24/2013 (see Annex II for details).

During this time, Key Experts (KE) will work in St. Vincent and Union Island. During the first 14 days, they will participate in briefings, define the field work operations and the best strategies, determine the area to be surveyed, and plan several additional logistical details that need to be arranged for the project phase II. During phase I, KEs also participated in the Regional Validation Queen Conch Fisheries Management workshop, and in the Queen Conch and Lobster Working Group meeting.

This provided the opportunity to learn about the most updated conch status based on fisheries-dependent information across the region. The KEs were also able to engage with representatives of countries about information needs and availability of queen conch surveys, along with any other relevant information such as GIS layers, habitat characteristics or fishing grounds within the area to be surveyed. The nine days following the departure of KEs will focus on the preparation and delivery of the draft interim technical report and beginning drafting of the queen conch survey manual.

Annex III presents pictures from various activities accomplished during KEs first visit to St. Vincent and the Grenadines.

Project phase II will be accomplished from June 25 to September 2013. The participants will meet in St Vincent on 5 August and receive training on conch biology, management, conservation as well as work related to the preparation of the field work activities over the next three days. Following this activity, the group will transfer by fast ferry to Union Island to begin field activities including the mock survey. The mock survey will have both SCUBA diving and towed-video sampling components. The group will then return to Kingstown for an additional 3 ½ days of classroom activities related to data entry, data analysis, GIS visualization, and report writing. Each participant will be expected to develop a strategy for sampling conch in their country.

It is expected that participants will learn about survey design, field work preparation, data collection from shallow waters (from the surface to 25m in depth) and deep water (26-50m in depth), data entry, analysis, report generation with management recommendations and regional consideration for extending the queen conch survey in the Caribbean Forum ACP States. Final conclusions and considerations will be given in regards to future queen conch surveys within the different countries. Participants will receive a draft survey manual for their review prior to the meeting in St. Vincent. Preparation of the draft final report and edits to the interim technical report and survey manual will be conducted following the St. Vincent workshop. Updating of final project outcomes will be produced during September, 2013.

The mock survey will cover an estimated total area of 248km^2, of which the shallow areas (less than 25m in depth) account for 36%; deep areas (between 26 and 50m in depth) represent the remaining 63% accordingly with the 25m depth contour as defined in the B3 Grenadines nautical chart (Figure 1). Queen conch populations within the shallow waters will be surveyed during seven days of scuba diving. The surveys will be conducted by working out of two boats simultaneously, thus expanding the potential to reach more areas. Deeper populations will be observed from a towed system rented from the University of West Indies, Cave Hill campus.

As part of the training, additional environmental/management criteria including preferred queen conch fishing grounds and influences of marine reserves areas will be considered. Information from the MARSIS web database (available from www.grenadinesmarsis.com) indicates that within the selected area there will be around 31% of the preferred fishing grounds, and 31% of the currently designated marine reserves (Figures 2-3).

Safety issues are being taken seriously; the requirements for participation are stringent and have been clearly expressed in the Letter of Invitation and its complementary Information Note. Dive insurance and emergency plans are requirements provided by the dive operator.

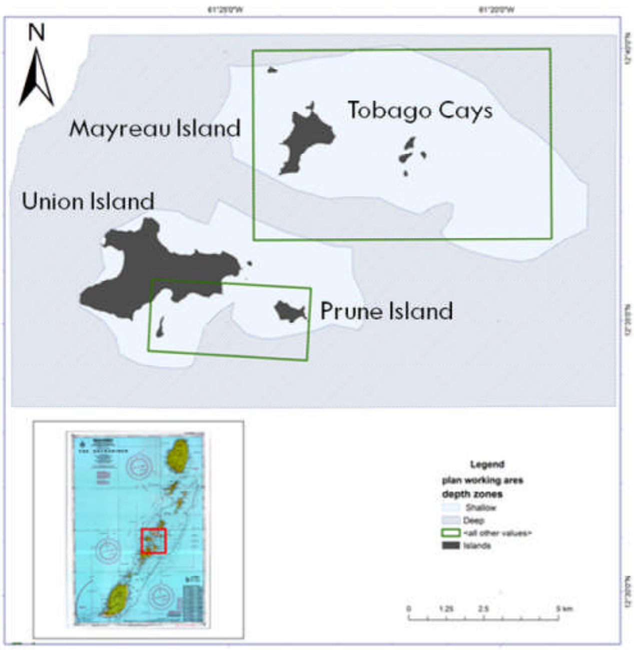


Figure 1. Preliminary selected areas to be surveyed during the project phase I developed by KEs. Final adjustments to, and agreements on, the station locations and survey design are considered part of the training course. The 25m bathymetric contour obtained from B3 Grenadines nautical chart delineates shallow from deep water areas. Background maps denoting location of islands and conservation zones were obtained from the MARSIS web database available from www.grenadinesmarsis.com.

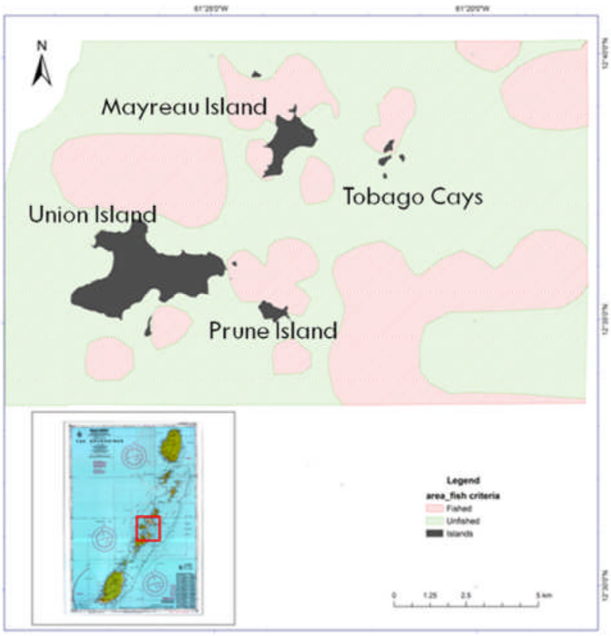


Figure 2. Preliminary information about spatial distribution of preferred queen conch fishing grounds within the area to be surveyed obtained from the MARSIS web database available from www.grenadinesmarsis.com. This information will be considered for final station locations.

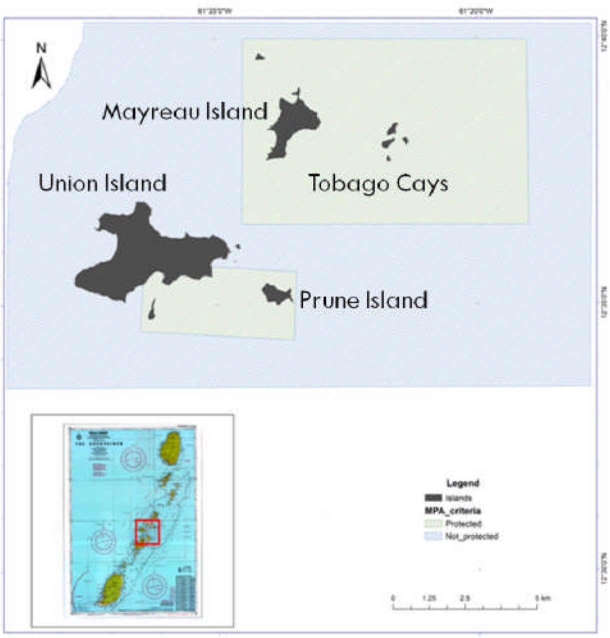


Figure 3. Preliminary information about spatial distribution of marine reserves within the area to be surveyed obtained from the MARSIS web database available from www.grenadinesmarsis.com. This information will be considered for final station locations.

4. Set up and members of the Technical Team

The technical team for this project is comprised of the following members: a) Susan Singh-Renton from the CRFM Secretariat, b) Jennifer Cruickshank-Howard from Fisheries Department in St. Vincent and the Grenadines; and c) Martha Prada and Robert Glazer from SOFRECO.

The technical team, supported by Sandra Grant from ACP Fish II; convened at the CRFM Secretariat office in St. Vincent on June 3, 2013 where they discussed and agreed upon major issues related to the development of this project. During the following five days, specific issues were presented by the KEs to the technical team members; feedback and recommendations provided by the Technical Team are included in this inception report.

5. Proposed work plan

As mentioned before, the project will be developed in two phases: phase I related to the preparation and information compilation, and phase II for the actual implementation of the Training of Trainers course. Detailed activity and the timeline are presented below.

		Year	2013													
		Month	June				July				August				September	
		Weeks	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
No.	Location	Activities														
		Phase 1 : Inception phase and reporting														
1	St Vincent Island	KE arrive to St. Vincent														
2		Briefing in St. Vincent and the Grenadines with the ACP Fish II Programme and the CRFM Technical officers.														
3	Union Island	Visit the area to be surveyed, look at local conditions and diving set-up operations, along with acommodation alternatives, safety considerations														
4	St Vincent Island	Participation in the queen conch fishery managament workshop														
5		Consultation with country representatives data for interim report, preparation of formal request questionary for this information														
6		Preparation of participants invitation letter along with a complementarily information note to be sent by CRFM Secretariat														
7		Continuation coordination for logistic ande scientific issues for the mock survey														
8		Preparation and delivery of inception report		▲												
9		Gathering GIS information and other complementaty information from CERMES University														
10	Colombia/USA	KE departure from St. Vicent														
11		Preparing and submitting Training Manual and Interim Technical Report.				▲										
		Phase 2 : Training workshop and reporting														
12	Colombia/USA	Continue preparation for logistics, equipments, GIS tools, and webinar set up														
13	St Vincent Island	KE arrive to St. Vincent														
14		First class toom lessons and field work proparation														
15	Union Island	Diving at shallow water sites														
16		Exploring deep water sites														
17	St Vincent Island	Second class room lessons: data anlysis,GIS and GPS use, group discussions, analysis, conclussions and recommendation, survey report														
18		Preparation of a Press-Release and presentation at a media coverage of the project activity.											▲			
19	Colombia/USA	KE departure from St. Vicent														
20		Preparation and Submission of Final Technical Report (FTR)													▲	
21		Preparation and submission of Final Report (after approval of FTR)														▲

▲ **Report submission** Phase 1 Phase 2

6. Results of initial document review, consultations and TNA etc

The following initial consultations were conducted related to queen conch fisheries independent sampling approaches and their use in queen conch management plan development. The date in parentheses represents the date the meetings were conducted:

1. **Dr. Kim Baldwin –Associated with UWI, baldwin.kimberly@gmail.com (5 June 2013)**

A meeting with the KEs was held while visiting Union Island. Dr. Baldwoin provided detailed digital GIS data for the areas around Union Island as well as the entire Grenadines archipelago and other areas in the eastern Caribbean. These data will be instrumental in the activities planned for the project.

2. **Jamaica**

a. Mr. Ricardo Morris, Fisheries Officer, ramorris@moa.gov.jm (5 June 2013)

Extensive program on Pedro Bank. They estimate biomass and use 8% of estimated biomass as sustainable yield. He will provide reports and other information. Additional reports and documents were provided by Dr. Hazel Oxenford of UWI.

b. Dr. Karl Aiken, Senior Lecturer in Zoology in the Department of Life Sciences, UWI, Mona Campus, kaaiken2002@yahoo.com (5 June 2013)

Will provide additional information

3. **St. Kitts and Nevis - Mr. Shawn Isles, Fisheries Assistant, St. Kitts and Nevis, thewayoflife1@hotmail.com (5 June 2013)**

There have been no conch surveys conducted in St. Kitts and Nevis but there is a keen interest in doing them. Almost all conch are harvested in Nevis. They have no spatial data related to habitat but suggested contacting John Knowles with The Nature Conservancy.

4. **Belize**

a. Reported by Dr. Paul Medley as part of ACP Fish II project. Additional clarifications provide by Mr. Mauro Gongora, Fisheries Officer, megongora@hotmail.com (6 June 2013) - Underwater surveys are conducted every 2 years inside and external to MPAs. Transects are random back-reef shallow-water surveys. They use 75% of harvestable (i.e. legal-sized conch) biomass as MSY. M. Gongora will provide additional reports.

b. Mr. Mauro Gongora - Fisheries Officer, megongora@hotmail.com (11 June 2013) – Mr Gongora copied documents related to Belize fisheries independent surveys

5. **Grenada - reported by Dr. Paul Medley as part of ACP Fish II project. (7 June 2012)**

No abundance surveys have been conducted but wish/need to conduct them.

6. **The Bahamas - reported by Dr. Paul Medley as part of ACP Fish II project with input from Lester Gittens, Fisheries Officer, The Bahamas, LESTERGITTENS@bahamas.gov.bs (8 June 2013)**

   Fisheries independent work conducted by Stoner et al. covering small populations. Most mapping is qualitative. Additional surveys conducted by Smith and van Nierop. He will provide reports.

7. **Barbados – Dr. Hazel Oxenford, CERMES, University of the West Indies, Cave Hill Campus. (10 June 2013)**

   Discussions on sampling methods for the queen conch surveys from Barbados. She provided relevant reports and scientific papers from there as well as other locations including Jamaica, Tobago, USVI, Turks and Caicos, Panama, St. Lucia, Antigua and Barbuda, the Netherland Antilles, Venezuela, and Guadeloupe.

7. Key issues to be addressed/solved

With regards to the training manual, during the inception meeting it was confirmed that the idea was to have a printed manual, but options for having an online option may also be a possibility. At this moment, no changes are expected; however, taking into consideration that the CRFM web server is being updated, the possibility to host a digital manual with videos will be explored.

The issue related to renting or purchasing a towed video camera system needs to be finalized.

All logistical arrangements for the training are under examination and should be finalized at the soonest to enable the smooth implementation of the event.

8. Recommendations

Although the core field activities have not yet begun, we can make the following recommendations based upon conversations within the Regional Validation Queen Conch Fishery Management Workshop and The Conch and Lobster Working Group meeting which were held from 6-8 June and 10-14 June respectively, in Kingstown, St. Vincent within which the Key Experts were present.

- The activities associated with TRAINING IN UNDERWATER VISUAL SURVEY METHODS FOR EVALUATING THE STATUS OF STROMBUS GIGAS, QUEEN CONCH STOCKS workshop should be made available to countries other than those identified within the Terms of Reference in future trainings.
- In order to add context to the sampling and provide a holistic framework, we suggest that additional sampling approaches that inform conch management should be included in future trainings such as plankton sampling.
- An emphasis should be placed on reproduction in all future projects. We intend to address this issue in the training but there is a need for it to be explicit and a primary focus.

9. ANNEXES:

I. Power point presentation given to countries representatives and resource managers participating in the validation workshop for queen conch regional fisheries management.

II. Calendar detailing project activities

III. Photographs during project phase I.

IV. Document review.

ANNEX I. POWER POINT PRESENTATION OF THE PROJECT

Power point presentation given to countries representatives and resource managers participating in the validation workshop for queen conch regional fisheries management.

Training fisheries officers ACP Fish II Programme

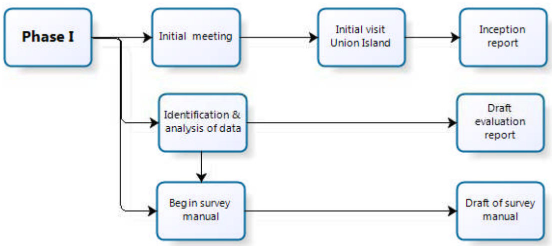
- Jamaica
- Belize
- Dominican Republic
- The Bahamas
- Antigua and Barbuda
- St. Lucia
- St. Kitts and Nevis
- Grenada
- Haiti
- St. Vincent and the Grenadines

Objectives

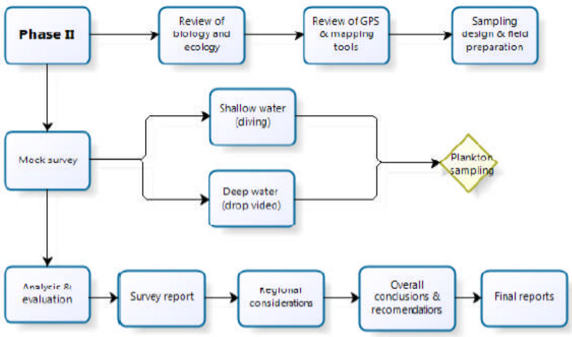
- Build capacity of fisheries officers using underwater visual survey methods for the management of queen conch
- Develop a survey that can provide fisheries independent data for queen conch for Tobago Cays Marine Park and the surrounding area

Main Activities

- Regional evaluation of fisheries independent approaches including shallow-water and deepwater stocks
- Develop a manual for surveying and analyzing queen conch
- Mock Survey including data collection, data storage, analyses, and reporting
- Final products



June-July, 2013

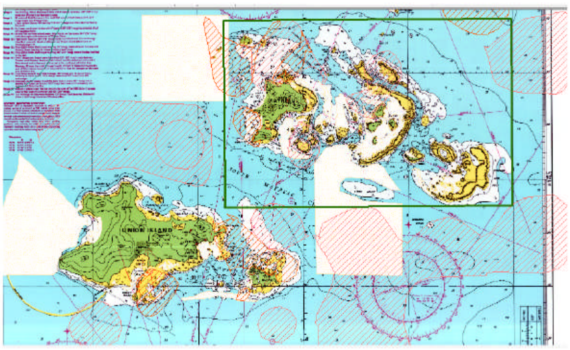


August-September 2013

Final Products

- Review of Fisheries Independent Approaches
- Manual for fisheries independent surveys
  - with Case Studies
- Development by attendees of framework for assessments in their country
- Development of analysis capacity within countries
- Estimate of conch biomass by age around Union Island

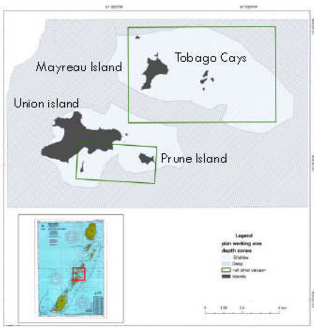
Where???



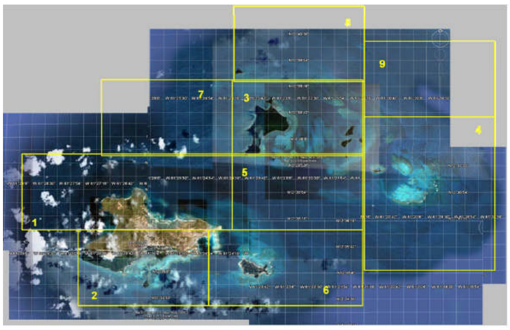
Factors to be considered

1. Spatial variability based on: depth, habitat type, MPAs, channel influences.
2. Shallow (diving) versus deep (drop camera) queen conch populations.
3. Additional information for queen conch recruitment (plankton samples).
4. Additional biodiversity information.

Selected Area

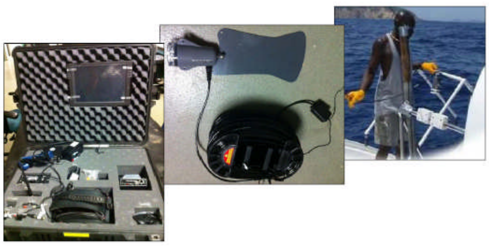


Mock survey



Shallow-water surveys

Deepwater Surveys



Qualifications of Participants

1. Certified diver and conducted at least two dives in the last 6 months
2. Work with fisheries/conservation, or be a fisherman
3. Have an interest in learning about queen conch bio-ecology towards sustainable fishing
4. Ability to work in a team
5. Be in good health

Items to be provided

1. Boat, scuba tanks , weights and other equipment for diving
2. Sampling equipment
3. Diving insurance for all participants
4. A per diem to pay for accommodation and food (special group arrangements are being negotiated)

Items to bring:

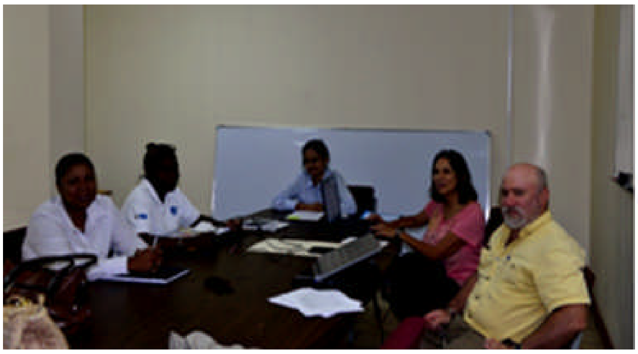
1. Mask, fins, snorkel, and a protecting skin or neoprene wetsuit
2. Desirable to have their own regulator and BC
3. A laptop computer
4. A hand held GPS unit
5. Ideal to have a photo/video camera with a underwater housing and a diving computer (not required)

ANNEX II. CALENDAR DETAILING TRAINING ACTIVITIES

August 2013

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
28	29	30	31	1	2	3
4	5	6	7	8	9	10
	Arrive Kingstown, SVG	Overview of Queen conch Biology, Management, Conservation, Survey Techniques			Fast Ferry to Union Island, Grenadines Dive Check - Out	Diving
11	12	13	14	15	16	17
OFF	Diving Surveys and Transects					
18	19	20	21	22	23	24
OFF	Deepwater Video Surveys		Fast Ferry Union Island to Kingstown Begin Survey Reviews	Review surveys, conduct analyses, create country-specific frameworks		
25	26	27	28	29	30	31
Depart Kingstown, SVG						

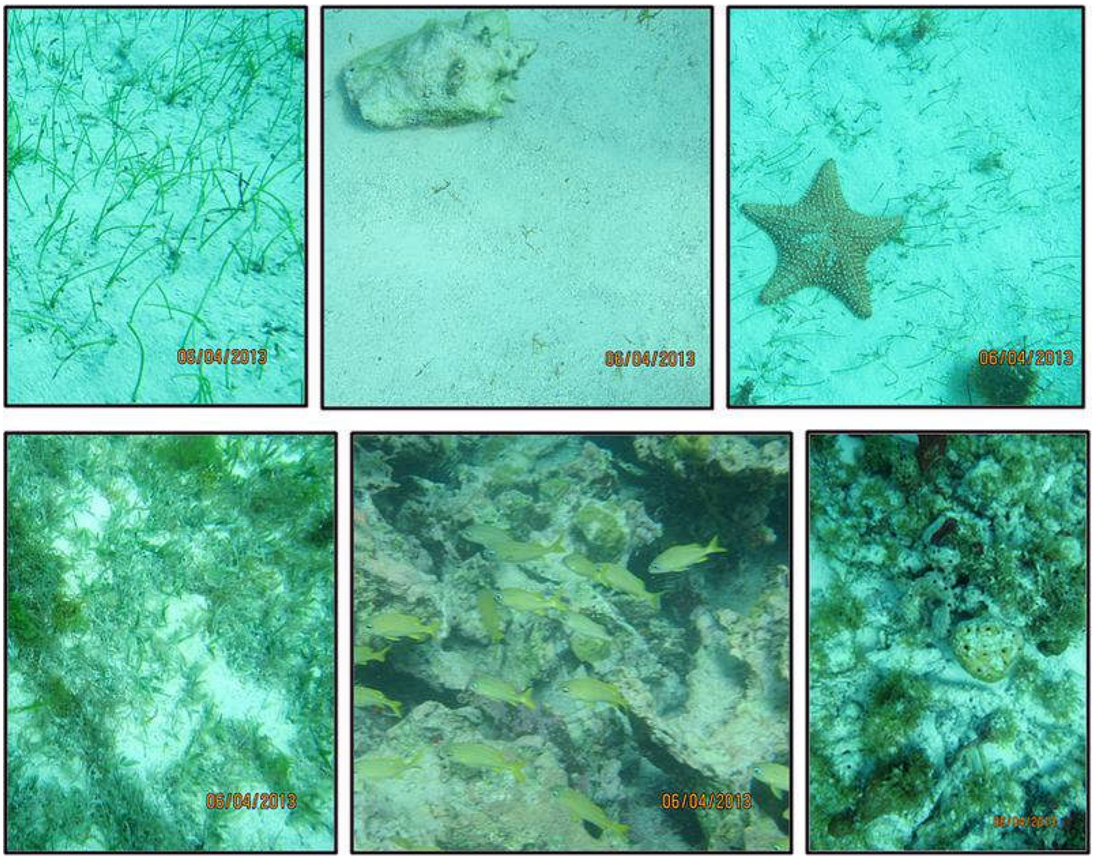
ANNEX III. PHOTOGRAPHS DURING PROJECT PHASE I.



During the inception meeting at CRFM Secretariat on June 3, 2013.

Field work operations planning meeting at Grenadines Dive Store with Albert Hanson from Tobago Cays Marine Park, Kris Isaacs from St. Vincent and the Grenadines Fisheries Department, Glenroy Adams from Grenadines Dive and the two KEs.

Artisanal queen conch fishermen interviewed about fishing grounds and fishing techniques at the landing site in Union Island.



Various benthic habitats inspected around Tobago Cays Marine Park for future underwater queen conch surveys at shallow waters.

One of the two boats to be contracted for the field work operations during the mock survey.

KE participation in the Regional Validation Queen Conch Fisheries workshop held during June 6-8, 2012 at the Methodist Church conference room, in Kingstown, St. Vicent.

ANNEX IV. DOCUMENT REVIEW.

The following documents were collected during Phase 1 in St. Vincent. These documents will be added to those already compiled by the KEs.

Author(s)	Year	Country	Date	Title
Aiken et al.	1999	Jamaica	Ocean and Coastal Management	The queen conch fishery on Pedro Bank, Jamaica: discovery, development, management
Aiken et al.	2006	Jamaica	Ocean and Coastal Management	Managing Jamaica's Queen conch resources
Chalifour		Guadeloupe	GCFI	Development of an evaluation method of the queen conch (Strombus gigas) resources in Guadeloupe and application to eight marine sites in the archipelego (Abstract only)
Clerveaux and Danylchuk	?		GCFI	Visual assessment of queen conch (Strombus gigas) stocks in the Turks and Caicos Islands: cross checking yield estimates
Davis	2003	St. Eustatius	Report of St. Eustatius Marine Park	Population assessment of queen conch, Strombus gigas, in the St. Eustatius Marine Park, Netherland Antilles
King-Joseph et al.	2008	St. Lucia	Report to the Miniustry of Economic Affairs, Economic Planning, Investment and National Development	Conch Resource Assessment Study
Medley and Ninnes	1999	Turks and Caicos	Bull Mar Sci	A stock asessment for the conch (Strombus gigas L,) fishery in the Turks and Caicos Islands

Oxenford and Parker	2009	Barbados	Final Paper	A preliminary management plan for the queen conch (Strombus gigas) fishery in Barbados
Oxenford et al.	2008	Barbados	Report	Preliminary assessment of the abundance of queen conch, Strombus gigas, along the southeast and southwest coasts of Barbados
Oxenford et al.	2010	Barbados	Report	Assessment of the queen conch, Strombus gigas, in Barbados
Schweizer and Posada	2006	Venezuela	Bull Mar Sci	Distribution, density, and abundance of the queen conch, Strombus gigas, in Los Roques Archipelego National Park, Venezuela
Smikle and Appeldoorn	2003	Jamaica	Report to Fisheries Division	2002 Estimates of abundance and potential yield for the Pedro Bank queen conch population
Tewfik and Guzman	2003	Panama	J Shellfish Res	Shallow-water distribution and population characteristics of Strombus gigas and S. costatus (gastrpod: Strombidae) in Bocas de Toro, Panama
Tewfik	1991	Jamaica	MSc Thesis	An assessment of the biological characteristics, abundance, and potential yield of the queen conch (Strombus gigas) fishery of the Pedro Bank off Jamaica
Tewfik	2002	CARICOM	Report	Regional overview of queen conch (Strombus gigas) resources in CARICOM/CARIFORUM countries
Tewfik et al.	2001	Antigua and Barbuda	Report to CARICOM Fisheries Unit	Antigua and Barbuda queen conch abundance survey (1999)
Tobias	2005	USVI	Report to the SEAMAP-C	Assessment of conch densities in backreef embayments on the northeast and southease coast of St. Croix, U.S. Virgin Islands
Capture Fisheries Unit	2010	Belize	Report	Belize conch stock assessment report 2010
Capture Fisheries Unit	2012	Belize	Report	Belize conch stock assessment report 2012
Baldwin	2012	Grenadine Islands	Thesis-UWI	A participatory marine resource and space-use information system for the Grenadine Islands

<u>Additional Data Collected</u>   <u>Kim Baldwin</u>

Compilation of GIS Data
Grenadine Pas
Nautical Charts
ReefFix_CCC_Tobago Cays
SVGRIS
TNC_Data
Final_MSP_ZoningDesign

Annex II: Review of Underwater Fisheries Independent Approaches for Queen Conch Population Estimations

REVIEW OF UNDERWATER FISHERIES INDEPENDENT APPROACHES USED FOR QUEEN CONCH POPULATION ESTIMATION

Training in underwater visual survey methods for eveluating the status of *Strombus Gigas*, Queen Conch Stocks

Project ref. N° CAR/3.2/B.14

Table of Content

Introduction

Fisheries independent monitoring (FIM) approaches are often used to evaluate fish and invertebrate populations either alone or in conjunction with fisheries data. Because FIM sampling is based on techniques that do not require catch data, they are often conducted using sampling designs that address the specific habitat-based population distribution. For this reason, these studies are often considered to be ecosystem-based. Specifically, FIM approaches may allow for methodologies to determine population attributes in a more holistic and ecosystem-based assessment regime by stratifying sampling based on habitats and water depths.

Queen conch have a number of attributes that makes them desirable for ecosystem-based approaches for sampling and management [1]. For example, conch have very specific habitat requirements, especially for reproduction, that are quantifiable and easily incorporated into sampling protocols.

Figure 1. A diver measures siphonal length of a conch in a fisheries independent conch survey.

Conch also have a number of specific attributes that are directly related to developing strategies that ensure the sustainability of populations and which cannot be assessed using traditional capture data. For example, conch exhibit density-dependent reproduction with very well-defined density thresholds below which reproduction will not occur. Ascertaining the density of a population using methods other than direct enumeration is, therefore, problematic.

Furthermore, FIM methods facilitate sampling conch 'in the shell' (Figure 1) which provides more accurate age and growth information when compared with fisheries-dependent methods. Conch exhibit determinate growth; at the onset of the flared lip (approximately 3.5 years) the shell growth represented by siphonal length (i.e., the length from the notch on the anterior part of the shell to the tip of the spire) ceases and all further shell deposition inside the flared lip thus increasing the lip thickness. As the lip thickens, the meat weight may actually decline. The problem arises in estimating the age of the conch. In most conch fisheries, the animal is not landed in the shell; rather, the animal is cleaned at sea, the shell is discarded, and only the meat is landed. Because of the poor relationship between meat weight and age, it is very difficult to determine population demography (age of the population) using fisheries data. FIM methods overcome this deficiency because an observer is able to directly measure shell morphology in situ and thus a better estimate of population demography may be obtained.

There are other problems with using fisheries catch data to assess conch populations. Size-based harvest restrictions prevent sampling a full range of sizes in a population. In many locations in the

Caribbean region, regulations prohibit the harvest of juvenile conch. FIM methods overcome this sampling deficiency by permitting sampling of both juveniles and adults thus providing more robust recruitment estimations and identification of population structure.

FIM methods allow for sampling where fisheries based methods are not available such as in inaccessible locations related to deep water, areas far from shore, or within the boundaries of protected areas. These surveys may provide an understanding of the demography and reproductive output of unfished population. In the same vein, these methods facilitate comparisons between fished and unfished populations [2,3] that can provide a baseline for evaluating different management strategies.

Finally, FIM sampling permits managers to target specific locations to determine stock status that may be underrepresented in fisheries capture data. This is especially problematic because catch data may not be comprehensive or representative of the overall population. Throughout the Caribbean region, conch have been used for local consumption and these catches are often not reported in traditional fisheries landings data thus resulting in underreporting of catch.

Nevertheless, fisheries dependent monitoring approaches have been widely used to estimate the abundance of queen conch populations, to estimate harvestable biomass, and to set catch quotas. In these more data-rich cases, fisheries independent monitoring approaches can complement these programs by providing information on spatial and depth distribution, population density, habitat associations, reproductive behavior and output, and other variables that would not otherwise be collected using fisheries-based approaches (e.g., reproductive activity, habitat associations, indices of recruitment, spatial distribution). Results from a FIM program within an existing data-rich fishery can provide an independent index that may corroborate results, elucidate deficiencies, or complement fisheries-based approaches. For this reason, incorporating FIM methods is often cited as a desirable step in developing quotas and sustainable yield estimates as well as understanding the status of conch stocks [4,5,6,7,8,9].

Even in locations where there are good capture data, FIM sampling may be used to set quotas. For example, in Belize populations are surveyed using transects surveyed by divers. Harvestable biomass is estimated from these surveys and the catch quotas are developed from these estimates [10,11,12]. Jamaica [13,14], Honduras [15,16,17] and Nicaragua [18] have also used FIM methods to set fisheries quotas. The latter two studies used FIM methods by employing the commercial industry to conduct the surveys in association with their ongoing fishing activities.

For all the reasons detailed above, a large number of studies have examined queen conch populations and ecological associations using surveys conducted using divers. These studies are detailed in the included summary table (Table 1.)

This review is meant to provide an overview of how fisheries-independent approaches have been used for conch surveys, the types of survey approaches that have be used, the advantages of each method, and the difficulties or deficiencies provided by each methodology. The various methods are presented with a brief overview of their use. The specific studies and countries where the approaches were used, along with the advantages and disadvantages are then detailed in more depth in the associated table. It has been our intent to be as comprehensive as possible but it is likely that we may have missed one or more studies due to the extensive literature based in peer-reviewed, gray, and unpublished literature. The data was collected through an extensive literature review as well as in-person contacts during conch workshops conducted in St. Vincent and the Grenadines in June 2013. Additional literature was collected from personal contacts. Finally, we present an extensive bibliography of references that are cited in the text and the table.

As we discovered, some countries have been conducting studies for a long period of time and have extensive datasets (e.g., Florida, The Bahamas, Jamaica, Belize). Others have relatively poor knowledge of their conch populations. With the inclusion of *Strombus gigas* within Appendix II of CITES, more countries have become interested in understanding the status of their population and the exploitable biomass their resources may present.

It was not our intention to provide critical analyses of specific programs or projects; rather, our intention was to review the use of these techniques and provide an evaluation of their efficacy under different conditions. In that spirit, we hope to point out when the techniques are most appropriate and when they are inappropriate, inefficient, or unsafe. It is up to individual countries or territories to determine the usefulness of each approach based upon their specific case with regard to the area under consideration, the distribution of the conch population (e.g., depth distribution, habitat associations, the aggregated nature of the population), the resources available (including financial and human), the level of training of the individuals conducting the surveys, and the capacity of the organization conducting the surveys.

The references that are included refer to studies where specific techniques are described rather than reporting solely on the results of the surveys. We also do not report studies within which the methodologies are not sufficiently detailed to determine what method was used to collect the data even though it may be apparent that it was collected using fisheries-independent approaches.

Fisheries Independent Approaches Used for Conch Surveys

FIM methods for conch surveys have been used to sample either entire populations or representative samples of the populations. Standard sampling methods have been applied and modified for the specific biological attributes of conch, habitats occupied, and the constraints related to underwater sampling. Similarly, statistical analyses use standard approaches adjusted for the distributions associated with conch populations.

In this review, we have subdivided the survey techniques into those methods that are designed to rapidly survey large areas represented the entire cross-shelf area are surveyed (i.e., surveys using towed divers, scooters, and towed video systems) and those where smaller, representative areas are surveyed (e.g., belt transects and quadrats). Each approach has its advantage. However, these categories are not exclusive and both can be used to derive cross-shelf density and abundance estimations. For example, in some cases, belt-transects (The Bahamas [22,39,70], Belize [12], Colombia [26,27]) and quadrat sampling (Barbados [19,20,21]) were used to estimate entire, cross-shelf populations.

In some cases, a number of methodologies were used together. For example, in The Bahamas [22] and St. Eustatius [23], both quadrats and belt transects were used to estimate conch densities. Areas to be surveyed often are determined using habitat maps developed from aerial imagery [23], satellite imagery [24,25] or pre-developed GIS maps [26,27].

In a number of cases, fishermen were used to determine the location of the areas to be surveyed [23,26,27,28,29,30]. In Honduras [15,16,17] Jamaica [13],and Nicaragua [18] fishermen conducted the surveys in conjunction with ongoing commercial fishing activities. In some cases fisheries dependent and fisheries independent approaches were used together to estimate conch abundance (e.g., Honduras [15,16], Nicaragua [18],Jamaica [14], and St. Lucia [29]).

FIM studies have been conducted in numerous countries (Table 1.) Generally, each study used one methodology although there are a few studies in which a broader approach (e.g., surveys using towed divers) was used to determine the extent and general distribution of conch populations, and higher resolution studies were used to determine more precise population parameters. For example, manta tows were combined with belt transects in the Turks and Caicos to examine the habitat requirements of conch within a marine reserve [25]. In the Dominican Republic, towed divers were used to conduct a coarse evaluation of conch distribution and then the areas where conch were found were sampled more intensively [31]. In Florida, surveys using towed-divers were conducted to first establish the distribution of the conch population in the region [32] and, subsequently, more focused studies were used to estimate recovery of the spawning stock [36].

There are a number of techniques that have not been used much in estimating conch populations. In rare cases, line transect methods were used [34]. In this approach, all conch visible perpendicular to a transect line are noted and used in the data analyses. These types of approaches suffer from a 'sightability' bias which refers to the decaying ability to identify an individual the further it is from the line. In conch surveys, especially those which use towed divers, sightability can be a significant issue due to changing conditions (e.g., visibility) within one transect thus resulting in changing sightability values.

Some techniques have been used rarely but have value in certain circumstances (e.g., mixed-gas diving [35].) Other techniques have not been used as far as our research has uncovered but may have value in certain circumstances (e.g., AUVs, surveys from submersible platforms, ROVs.)

Survey Methods That Sample Large Areas

Strip transects using Towed-Divers (Manta tows) and Scooters

These approaches have found favorable use where large amounts of area need to be surveyed and the need is to cover as much area as possible. In that spirit, towed-divers (Figure 2) and scooters have been used to establish cross-shelf densities and abundance usually in units of number of individual per hectare. This method has been used in Florida [32,37,86], Bermuda [38], the Turks and Caicos [25],The Bahamas [3,39, 40,41,42,43,44], the U.S. Virgin Islands [45,64]and St. Lucia [46,47].

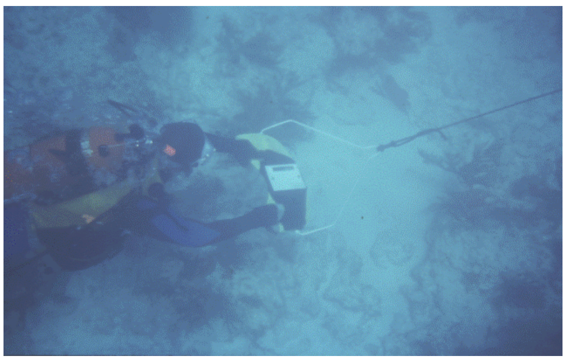


Figure 2. A diver towed by a vessel to estimate conch densities.

In some cases, the beginning and end points were delineated with deployed marker buoys [48]. In other cases, GPS [28] or LORAN systems [32] were used. Land-based features were also used to estimate distance traversed [49].

In general, this approach can cover vast distances with little effort. Densities (generally reported as individuals per hectare or individuals per square meter) may follow the negative binomial (clustering) distribution which presents difficulties from an analytical perspective.

The status of live versus dead conch is often difficult to establish. If line transects are conducted (rather than strip transects), sightability can be an issue and correctly calibrating for this variable can be difficult. Furthermore, sightability may change within one transect.

Other data may be difficult to ascertain. Specific reproductive behavior may be difficult to categorize when towed. Intra-aggregation densities may be difficult to establish because in general spatial distribution of the conch within the transect (i.e., where along the transect an individual was found) are not reported.

Video transects

In general, video transects have been used to sample areas that are beyond the limits of safe-diving. The location where it has been used most extensively for surveying conch is in the French West Indies [50,51] (Figure 3). In Florida (Figure 4), these methods have begun to be used to assess deepwater conch populations (from 15m – 70m)[Glazer personal observation]. In both cases, only 3 people are needed to run the video equipment. These include a boat driver, a camera operator, and a navigator.

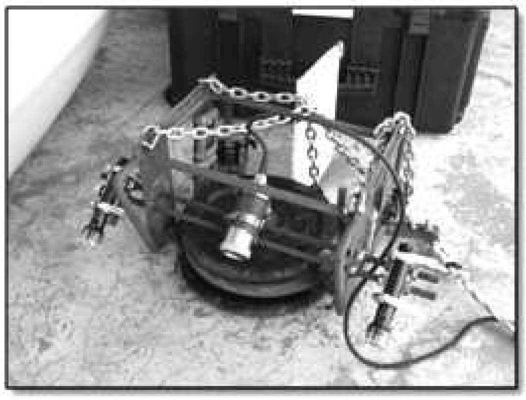


Figure 3 Underwater video equipment used in the French West Indies [14,86].

This method provides the benefit of accessing deep water conch aggregations that are at or below the limits of safe diving. Virtually unlimited time can be spent at depth.

There are a number of issues that make this approach potentially problematic. First, a great deal of funding is necessary to purchase the equipment. In 2013, approximately $3,500 was required to purchase the system which acquires the video. A second issue is the amount of post-processing that is required to examine the video. A third issue is that it may be difficult to determine of the conch are living, laying eggs, or the precise size of the individuals that are identified in the surveys. Finally, highly rugose environments are difficult to survey due to the potential for the equipment to entangle within three-dimensional structure. In order to identify conch within these surveys, the camera must be positioned close to the bottom. New, high definition systems are available, and these may provide better resolution at higher elevation, however, they suffer from requiring even more storage capacity and equipment expense.

Figure 4. Underwater video camera manufactured by SeaViewer and used in Florida surveys. Equipment in the left pane is self-contained data acquisition equipment with integrated screen, GPS (for overlay on the video, and Bluetooth glasses to visualize the video while traversing the bottom. Pane on the right is the camera and cable. Data is saved to an SD card which is read using standard video editing software.

Perhaps the most comprehensive evaluation of video transect methods was conducted in Statia [100]. In this study, researchers calibrated a towed-camera array (Figure 5) versus diver observations and concluded that using the camera system underestimated the total number of conch. Furthermore, distinguishing between *S. gigas* and *S. costatus* was problematic, although the researchers suggested that this could be overcome with more practice. They also concluded that the maximum speed that could be used was 1 kt. In shallow areas, divers were more effective. The researchers using this system measured the width of the transect by attaching laser pointers to the frame. The laser pointers delineated the width of the swath that was sampled.

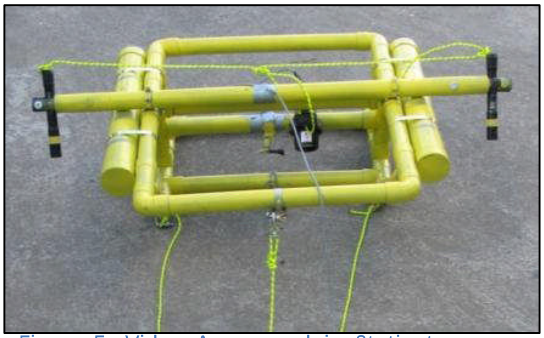


Figure 5. Video Array used in Statia to survey queen conch aggregations. The array uses a GoPro camera angled slightly forward

Towed-video transects are effective for examining a number of critical ecosystem-based parameters. For example, habitat is easily identified and quantified. Copulation is easily quantified; however, as mentioned, identifying individuals who are spawning (i.e. egg-laying) is very difficult. For those studies where quantification of Allee effects (i.e., depensatory reproduction) is a priority, this approach may be challenging.

Survey Methods That Sample Small Areas

Belt Transects

By far, the most FIM studies that were identified used belt-transects. This method consists of a measured transect length and conch within a pre-defined width either side of the transect are sampled (Figure 6). There are often a replicated number of belts and the mean density is used to estimate the overall density of the area under consideration.

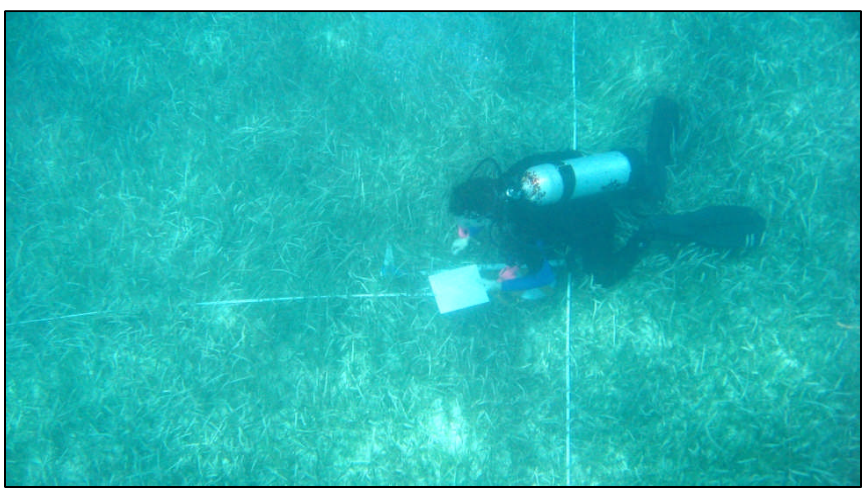


Figure 6. Diver surveying along a belt transect.

Belt transects have been used in a variety of habitats and at a variety of depths. They are often used in stratified sampling approaches. They have been used to categorize habitat associations, examine reproduction, estimate densities, and as a basis for calculating harvestable biomass. By far the majority of countries that have conducted FIM studies have used belt-transects.

Belt transects are a popular way of estimating densities [36,53]. The approach is well-suited for measuring densities either within well-defined, discrete aggregations or for larger, cross-shelf densities [22,26,27,39,70]. In general, the densities are reported as the number of individuals/hectare or the number of individuals/square meter.

Belt transects can only cover a limited area because of the labor required to deploy the sampling grid and the minimum amount of area that can be examined by a diver. In Florida, this method has been used together with a surface snorkeler to deploy the grid as well as measure the perimeter of the aggregation to arrive at both densities and overall estimates of abundance. Because of the relationship of the diver with the habitat, data related to environment and habitat associations are easy to collect. This approach provides a standard sampling unit and thus facilitates easy statistical evaluation in a replicated sampling design.

Length and width of belt transects are usually predetermined. In general, widths were determined using measuring sticks [53] or tethers [53,54,55,56] of predetermined lengths.

For transects with lengths that were not predetermined, divers sometimes used compass courses and flow-meters to estimate distance surveyed [53,54,57]. The number of kicks were also used as a method to quantify and standardize area sampled [23]. Timed-surveys were used in the Dominican Republic [31] and Venezuela [58].

This method has been used to examine attributes of protected areas [59,22,25] as well as recovery within protected areas [63].

Quadrat sampling

For the purposes of this review, quadrat sampling is used to describe a method in which all conch within a plot are sampled. This approach can be used for estimating critical population parameters (growth, mortality, abundance, recruitment) as well as movements and migration [60].

Quadrat sampling is useful when it is desirable to sample the entire contents of the quadrat; however, with high population densities such as juvenile aggregations, this approach may require too much effort with respect to sub-sampling representative random or stratified

Quadrat sampling was also used in The Bahamas to examine ecological associations [61,62]. For example, studies which examined Allee effects to identify densities below which no reproduction occurs were examined using these methods [87]. In both The Bahamas [3] and Venezuela [82], these approaches were used to examine densities in

<u>Circle Transects</u>

Circle transects are a type of quadrat sampling in which a centroid is identified and a radius is either predetermined or the area is surveyed based on the bottom time available to divers. Circle transects been used in The Bahamas [43], Barbados [20], and Jamaica [13] to estimate densities and abundance. All conch were counted within these plots.

fished versus unfished areas. In Barbados, this method was used to estimate total abundance for their conch population [19,20,21]. In some cases, quadrat sampling was used to recover tagged conch; however, tag-recapture surveys are beyond the scope of this review. In most cases, data used to examine ecological associations were collected as a bi-product to population sampling.

Table 1. Studies in which fisheries independent methods were used. Only studies in which the methods were described are included here.

Approach	Pros	Cons	Countries where the survey techniques were used (references are within brackets)
Strip or line transects using Towed-Divers (Manta tows)	• Good for cross-shelf densities • Can cover vast distances • Little effort required	• Poor for aggregation densities • Relatively unsafe • Limited to safe diving depths • Difficult analyzing • Difficult to determine live versus dead conch • Specific reproductive behavior may be difficult to identify (spawning, mating) • If line transects are conducted, 'sightability' can be an issue when towed. • Size distribution is difficult to determine • Limited to safe-diving depth • Difficult to determine width of transect in situ	• Florida [32,36,37] • Bermuda [38] • Turks and Caicos [25] • The Bahamas [33,53[1],39[2],40,41,42,43,44] • U.S. Virgin Islands [45] • St. Lucia [46[3],47] • Dominican Republic [31]
Strip transects using Scooters	• Good for cross-shelf	• Equipment intensive	• Puerto Rico [28,48]

[1] Snorkeling
[2] Snorkeling
[3] Abstract only

	densities • Can cover vast distances • Little effort required • Able to determine live vs. dead conch • Divers can leave scooters to take specific measurements • Divers can leave scooters to take specific measurements	• Limited to safe-diving depth • Difficult to determine width of transect in situ	• US Virgin Islands [64]
Belt transects	• Good for intra-aggregation densities • Good for nursery densities • Inexpensive • Easy to train technicians • Able to collect wide range of ecological and environmental parameters	• Limited to safe diving depths • Limited distance (area) can be covered so large shelfs require large efforts	• Antigua and Barbuda [65] • Belize [2,10,12,52] • Cuba [53,66,67,68,69] • Florida [32,63,37] • Puerto Rico [6,54,55,56] • Turks and Caicos Islands [24,25,59] • The Bahamas [22,39,70] • Colombia [26,27] • Haiti [XXX] • Honduras [34[4],71,72] • Dominican Republic [31,73,74,98] • Mexico (Alacranes)[75,76,77,78] • Mexico (Chinchorro) [79] • Mexico (Q roo)[80] • Nicaragua [81]

[4] Line transect method

			• St. Lucia [29] • Venezuela [58,82] • US Virgin Islands [83] • Panama [84]
Circle and Quadrat sampling	• Good for intra-aggregation densities • Good for nursery densities • Inexpensive • Easy to train technicians • Able to collect wide range of ecological and environmental parameters	• Limited to safe-diving depth • Limited are can be surveyed • Requires extreme amount of time for surveying extensive areas	• Barbados [19,20,21] • The Bahamas [22,61,62,85,86,87,88,89] • Mexico (Chinchorro) [90,91] • Mexico (Q. roo) [90,92] • Mexico (Cozumel) [93[5]] • Nicaragua [18[6]] • Turks and Caicos Islands [60] • Honduras [15,16[7]] • Jamaica [13[8]] • Venezuela [94] • Cayman Islands [95,96]
Towed-Video Transects	• Good for cross-shelf densities • Can cover large distances • Unlimited bottom time • Safe • Can examine habitats and locations inaccessible to	• Equipment intensive • Expensive • Requires investment in training • Requires extensive post-processing • Difficult to calibrate (e.g.	• Guadeloupe [50,51] • Florida [97] • Mexico (Chinchorro) [98] • Statia [100]

[5] Used hookah to collect all conch in swath
[6] Surveys conducted by commercial fishers
[7] Surveys conducted by commercial fishers
[8] Surveys conducted by commercial fishers

	divers due to safe diving depth limitations	distance from bottom) • Difficult to determine live versus dead conch	
Mixed-gas diving	• Good for intra-aggregation densities • Able to sample very deep areas • Unlimited bottom time • Safe • Can examine habitats and locations inaccessible to divers due to safe diving depth limitations	• Expensive – high equipment expenses • Requires extensive investment in training	• Puerto Rico [35]

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Annex III: Queen Conch Survey Manual

QUEEN CONCH SURVEY MANUAL

Training in the underwater visual survey methods for evaluating the status of *Strombus gigas*, Queen Conch Stocks.

EU funded project

Project ref. N° CAR/3.2/B.14 Caribbean
CRMF Member States

St. Vincent and the Grenadines
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QUEEN CONCH SURVEY MANUAL

CHAPTER I. INTRODUCTION

For centuries, the queen conch (*Strombus gigas*) has been one of the most iconic marine invertebrates across the Caribbean. The conch meat, shell, and pearls are all valued as important sources of income and the shell, in particular, has been widely used for construction and curios. The translucent pearls and shell are widely valued in jewelry. The shell has also has also been recognized as a cultural icon utilized for announcing important community events. Consequently, conch products in the Caribbean are consumed and utilized locally and are also frequently exported.

The queen conch is a tropical shallow-water species that lives in sand, seagrass, and coral reef habitats. It is subject to constant fishing pressure primarily from divers. The resource has been subjected to high levels of exploitation and, with increasing demands and prices in the international markets, the abundance of conch populations has diminished to the point that, in 1992, the species was listed in Appendix II of CITES (Convention on the International Trade in Endangered Species of Wild Fauna and Flora). This international agreement, legally binding to the Parties, is aimed at ensuring the species survival. To achieve this objective, CITES priorities include developing measures that ensure the sustainability of the fishery and counteract illegal trade. Because the early CITES measures did not stem the decline in regional abundance, two Significant Trade Reviews of queen conch were conducted in 1995 and 2003. These reviews resulted in prohibitions of queen conch exports from some countries, and further resulted in the adoption of special measures for improving non-detrimental findings.

The assessments of conch populations across the Caribbean has been difficult due to the intensity of the fisheries, biological characteristics that make the use of fishery population models difficult, and the paucity of data related to historical catch and fishing effort. As a consequence, management alternatives need to ensure harvest limitations while recognizing the importance of this traditional fishery. At present, reference points based on conch population densities have been regionally accepted as a sound practice for the maintenance of successful reproduction and recruitment.

Queen conch populations throughout the region are connected within a spatially complex patchy environment rich in coral reefs habitats comprising a variety of depths. In this context, estimations of densities of conch populations need to include spatial and temporal considerations. Underwater visual census methods provide the type of data necessary to evaluate the status of local populations independent from the sparse and low-quality fishery-based information. These fisheries-independent approaches can provide data that will assist managers in assessing population trends that are necessary to evaluate, and to recommend management approaches that apply the precautionary approach.

Underwater visual conch survey techniques also provide important biological/ecological information at the ecosystem level while at the same time facilitating the participation of managers, scientists and users in the analysis and reporting. This approach may have direct impacts on the decision-making process by perhaps enabling greater collaboration resulting in greater trust and buy-in that support queen conch conservation policies and regulations. Nevertheless, fishery-dependent data still needs to be collected and incorporated in analyses as complementary information, in order to have a much better understanding of the complexity of the resource and to better develop appropriate fishery regulations.

The objective of this manual is to present to the broader Caribbean audience a guide to the steps needed to conduct an underwater queen conch visual survey, including the planning and design tools and methods.

Data collection and analyses are covered. The biological rationale for each step is further discussed. It is expected that this manual will serve as an educational and outreach document for those people that love and appreciate the survival of the queen conch. It's use will provide an opportunity for more international cooperation, for better linkages between fishery managers and conservationists, and for better communication and exchange of information.

Because underwater surveys often require the use of SCUBA, safety considerations need to be incorporated into all surveys to minimize risks of hyperbaric trauma and, in the context of Caribbean society, the negative socio-economic impacts some queen conch communities are already experiencing.

It should be understood that the approaches and steps defined in this manual are meant to be adapted when appropriate to surveys in specific locations. In most cases, an attempt was made to broaden the applicability when describing approaches within this manual; however, in some instances some methods may seem best-suited for specific locations under specific conditions. This manual should serve as a guide for survey designers and that teams need to adapt this manual both prior to survey design, and also during the survey activities, to their particular situation.

This is a product generated by SOFRECO during the implementation of the project entitled "Training in Underwater Survey Methods for Evaluating the Status of the *Strombus gigas*, queen conch stocks" identified as the project CAR/3.2/B.14. The project is funded by the program ACP Fish II "Strengthening Fisheries Management in ACP countries" and directly benefits the Caribbean Regional Fisheries Organization (CRFM) and, in particular, the countries of Antigua and Barbuda, The Bahamas, Belize, Dominican Republic, Grenada, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines, within the Caribbean Forum.

CHAPTER II. BIOLOGY AND ECOLOGY KEY ISSUES

Objective:

At the conclusion of this chapter, trainees will refresh/learn relevant biological and ecological aspects of Caribbean queen conch, needed for better understanding of wild populations and for developing future fishery management recommendations.

2.1. Taxonomy

Strombus gigas is a large marine gastropod, first described by Linnaeus in 1758. The species common names varies throughout the Caribbean: lambie in several eastern Caribbean countries including the French speaking ones; queen or pink conch in several Caribbean English speaking countries, lambi in Dominican Republic; caracol pala in Colombia; caracol rosa in Honduras and Nicaragua; caracol reina in Mexico; botuto and guarura in Venezuela; carrucho in Puerto Rico; cambombia in Panamá; cambute in Costa Rica; and cobo in Cuba. Recent studies in the species taxonomy may re-group some of the genus in the future. The current taxonomy is:

Kingdom: Animalia
Phylum: Mollusca
Class: Gastropoda
Order: Mesogastropoda
Superfamily: Stromboidea
Family: Strombidae
Genus: *Strombus*
Species: *gigas*

FAO Species Identification Sheets separate this species from others in its family due to the large and moderately heavy shell, the outer large and thick lip with a U-shaped notch, the numerous short, sharp spires, the brown and horny operculum, and the bright pink shell with yellow borders (Figure 1).

The species has been reported in Florida, Bermuda, The Bahamas, the Turks and Caicos Islands, the Caribbean Islands, the Gulf of Mexico (including Texas), as well as the Caribbean shelves of the Central and South America (Figure 2).

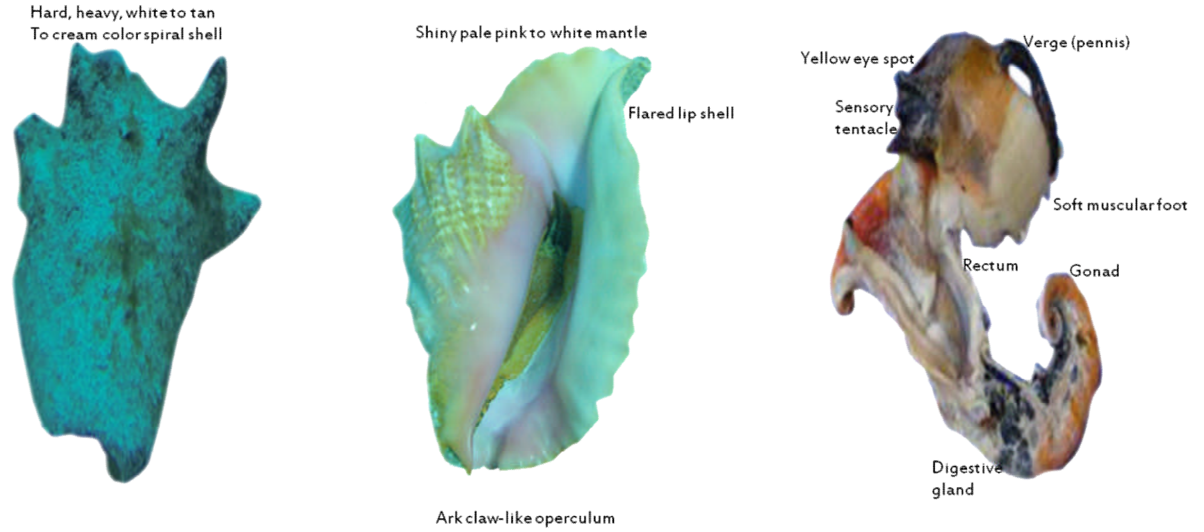

Figure 1. Pictures illustrating the queen conch morphology. Pictures taken by Martha Prada and Megan Davis.

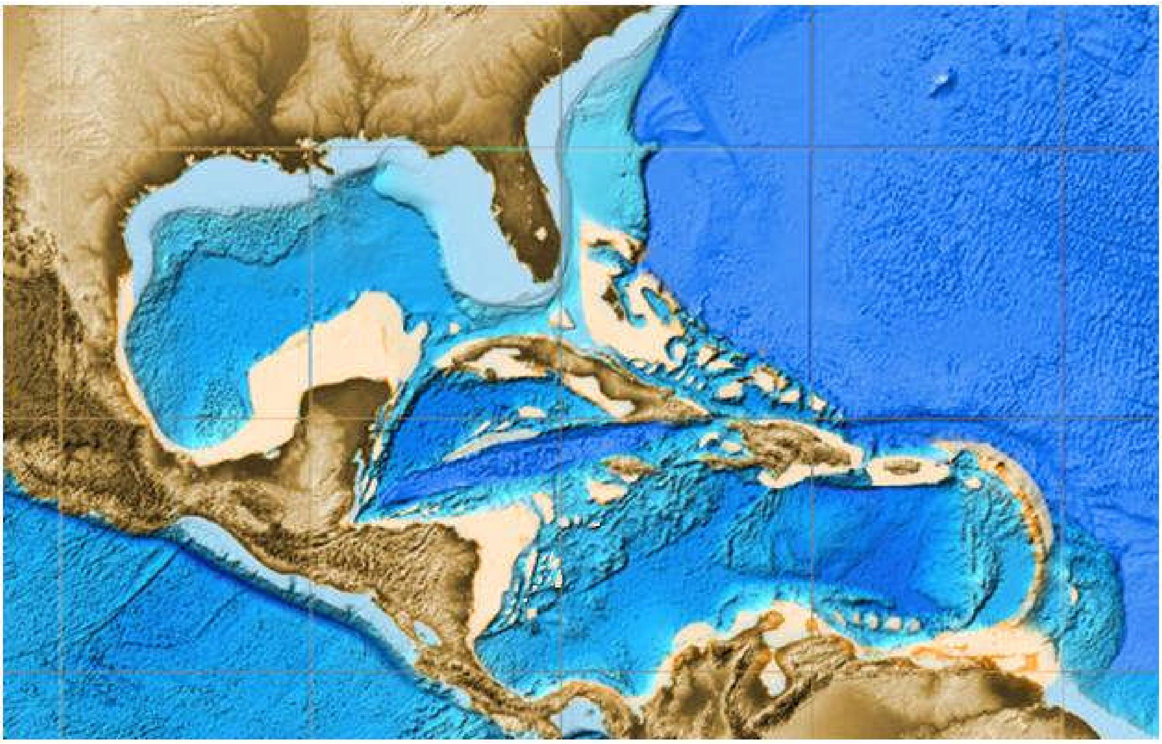

Figure 2. Highlighted (orange) shelf areas in the greater Caribbean denote the geographical distribution of the Strombus gigas or queen conch.
Based on map from NOAA National Geophysical Data Center (http://maps.ngdc.noaa.gov/viewers/bathymetry/).

2.2. Life History

As is true of many marine invertebrates, the queen conch has two life stages: one planktonic stage comprised of microscopic, free-swimming larvae, followed by a benthic stage associated with the seafloor (Figure 3). The planktonic cycle begins with the hatching of larvae from a crescent-shaped egg mass laid by adult females. Each egg mass contains from 400,000-750,000 eggs (Mianmanus 1988, Davis 1998, Aldana 2006). Egg masses are camouflaged with sand grains to aid survival through the three to four day incubation period. It is estimated, that a reproductive female can lay 7-13 egg masses per season.

The conch larvae or veliger emerges 3-5 days after spawning, and progressively develops multiple lobes known as the vela (singular: velum), and a transparent shell with one and a half whorls (Stoner et al 1992, Davis 1998). The vela assist in maintain the buoyancy of the veligers and also serve as a mechanism to exchange gases and to direct microalgae, the main food at this stage, towards its mouth. During first two weeks, veligers can be found at the surface and, as they age, they spend more time near the sea floor. Approximately 18-24 days after hatching, the larvae undergo metamorphosis in response to chemical cues exuded from red algae (Mianmanus 1988, Davis et al. 1990). Metamorphosis is achieved when the pigmentation of operculum changes from orange to dark green, the shell is larger and no longer transparent, the bronchial and muscle tissues develop, and, ultimately, the velum disappears. From now on, the queen conch will never swim again.

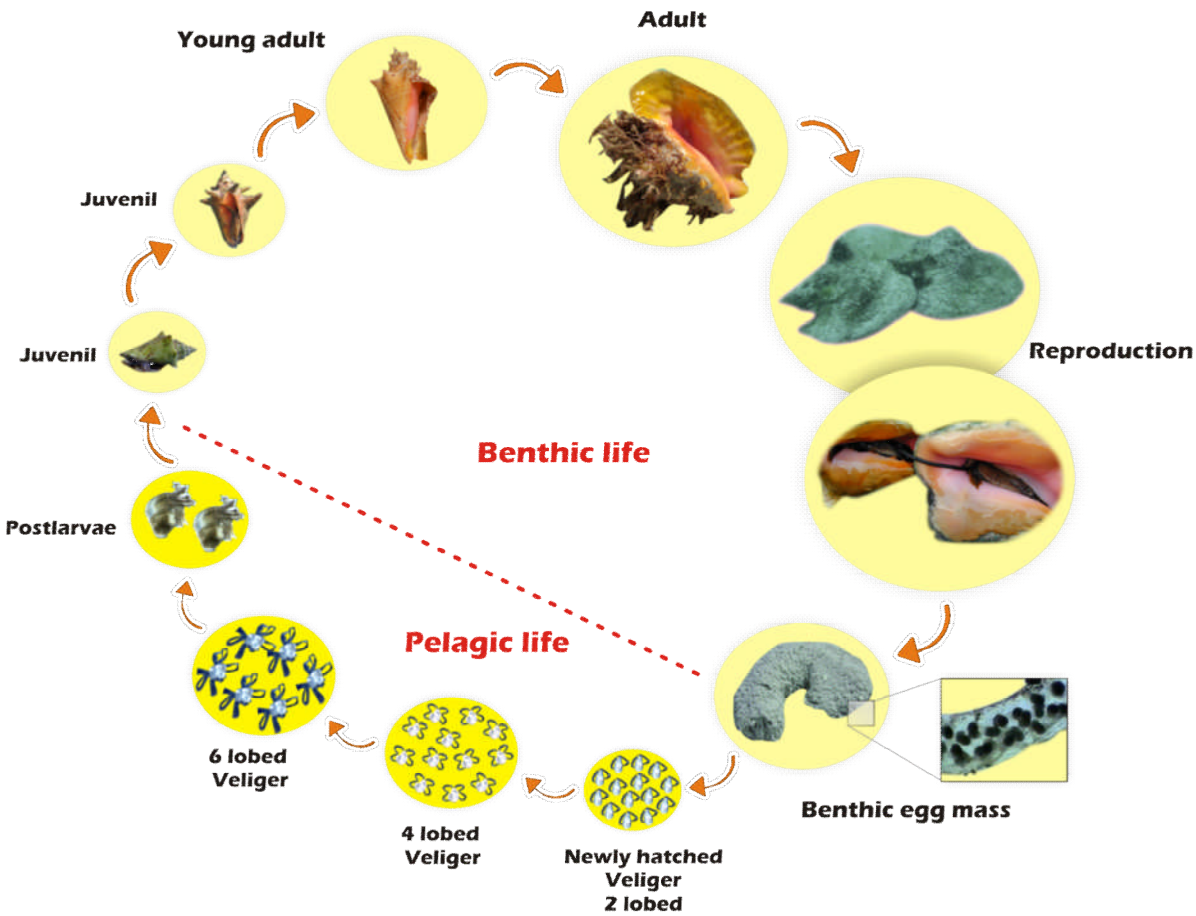

Figure 3. Diagram illustrating the several life stages of the queen conch. Pictures taken from Martha Prada, Erick Castro, Heins Bent and Megan Davis.

Early juveniles are 3-4mm Siphonal Length (SL). They are found buried in sandy habitats (Randall 1964, Sandt and Stoner 1992), emerging at night to feed. Progressively, the shell grows as its body grows bigger, becoming hard and thick. When the conch becomes an adult (i.e. at sexual maturation), it is about three and a half to four years old (Egan 1985, Appeldoorn et al 1987, Appeldoorn 1988, Stoner & Sandt 1992, de Jesus 2003). At this age, the shell is approximately 22cm SL with a lip thickness of about 5 mm. Recent studies have found that sexual maturity in queen conch does not occur until shell lip thickness reaches 8 to 15 mm (Egan 1985, Aldana-Aranda & Frenkiel 2005, Avila-Poveda & Baqueiro-Cárdenas 2006). Adult conch have a flared lip and, as they age, the spines become blunt and worn, and the shells often become covered with algae. Smaller animals often settle on the shells as if they were rocks. It is believed that conch can live up to around 20 years; in Bermuda, a live conch was found to have a coral growing on its shell that was 40 years old.

Queen conchs have separate sexes (Figure 4) and fertilization is achieved by copulation. Spawning typically occurs from March to October (Davis et al. 1984, Davis et al. 1994, Stoner et al. 1996a) although in the southern part of the range, they have been observed reproducing year round. Deep water conch (more than 40 m) in the French West Indies (Guadeloupe and Martinique) mature and spawn from June-October (Frenkiel et al. 2009, Reynal & Aldana 2009). During the reproductive season, large numbers of conch will migrate towards shallow waters (10m or less) and breed in coarse sandy habitats near reefs and *Thalassia testudinum* seagrass beds (Robertson 1959, Randall 1964, D'Asaro 1965, Brownell 1977, Weil and Laughlin 1984, Stoner and Schwarte 1994), forming reproductive aggregations. The high densities, and the relatively shallow-water in which they are found, make them vulnerable to exploitation. Successful reproduction depends on sufficiently high densities. According to Ávila (2004), in Colombian reefs, the complete gametogenic maturation cycle occurs from April through September; spawning occurs in two seasons in March-April and September, respectively. However, there is variation across the region with regard to the size and lip-thickness that can be related directly to the gametogenesis.

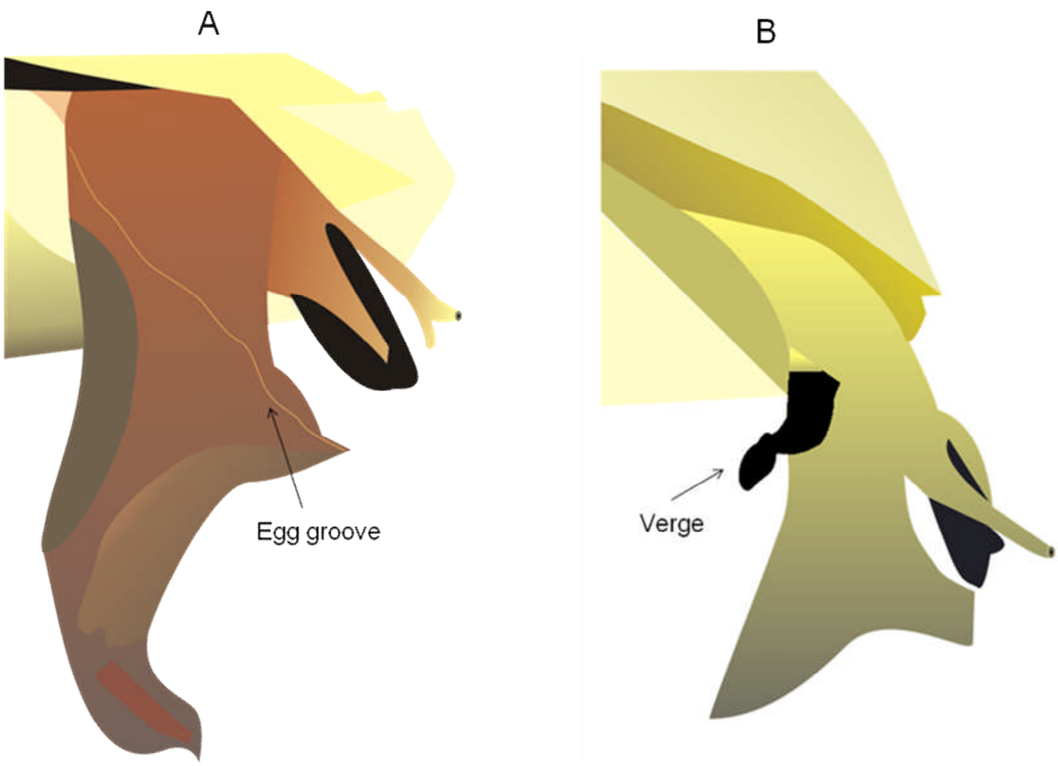

Figure 4. Illustration of queen conch sexual dimorphism: A. Female, B. Male. Drawing by Diana Prada.

2.3. Morphology

The queen conch has a large-lipped pink shell, (approximately 25cm or 10 inches SL), and has the highest commercial fisheries value of the six species within the Family Strombidae found in the western Atlantic. The head has two pairs of tentacles; the larger tentacles support the eyes whereas the smaller pair provides a sense of smell and touch. The large, muscular foot is that portion of the conch that is consumed. The foot protrudes from the lip of the shell and ends in an operculum or a hard thin oval disk that is used for locomotion, to fight with predators, and to seal itself tightly within its shell. Adult conch exhibit sexual dimorphism, with adult females having an egg groove on the right side of the foot; adult males develop a large black penis or verge also located on the right side of the foot.

The white conch meat constitutes the primary product of the fishery. However, the large, beautiful shell has also been prized by tourists (Figure 5). Queen conch pearls are less common, and by far the most valuable among the conch products. These pearls are formed by laying down concentric layers of fibrous crystals, then producing calcareous concretions with a porcelain finish. They are found in a wide variety and combination of colors including white, red, pink, orange, yellow and brown. Queen conch pearls are considered gemstones.

The measurements of the shell dimensions, the thickness of the lip, and the length of the operculum are all important morphometric variables. They are used to recognize the phenotypic variation among populations, and, in some cases, the potential differentiation of fishing stocks.

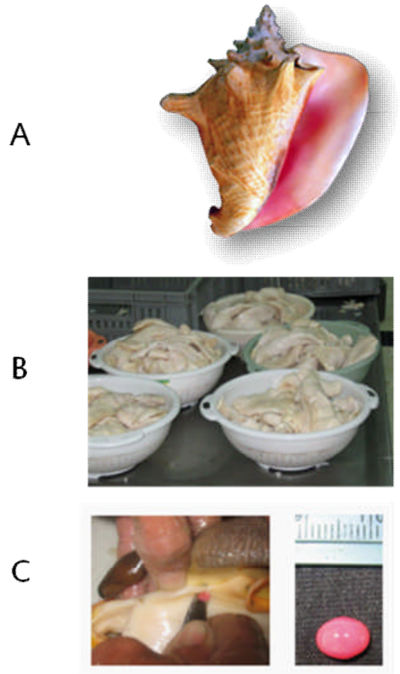

Figure 5. The three most valuable queen conch products: A. the pink shell, B. the white meat, and C. the colorful pearls. Pictures taken by Martha Prada and Oscar Ortegón.

2.4. Queen Conch Growth Variations

Variations in queen conch growth can be attributed either to genetic (heritable traits) or phenotypic (physiologic response to local conditions) factors. Currently, there is no consensus regarding the proportion that each factor influences queen conch growth at the population level. On one hand, patchy larval settlement may lead to distinct genetic populations, with perhaps periods of 5-10 years between settlement events. Alternatively, environmental conditions in different areas are associated with growth and morphological variations. Both mechanisms have the potential to influence conch growth rates and maximum size. In heavily fished sites, large conchs disappear rapidly in response to fising and this process eventually will lead to the dominance of small individuals thereby influencing the overall growth patterns of the population. It is well established that juvenile shell growth increases exponentially, with rates decreasing as adulthood nears. The length of the shell actually stops growing at sexual maturity, when additional shell deposition is dedicated to increasing lip thickness (Berg 1976, de Jesús-Navarrete 1997). Because of this determinate growth, queen conch shell length (siphonal length) should only be used to estimate age until sexual maturity is attained; thereafter, lip thickness can serve as a proxy for age. This growth pattern makes applying fishery models to populations extremely difficult.

On the other hand, spatial and temporal variations in the queen conch growth have been well-documented for more than 50 years (Table 1).

Table 1. Spatial variation in growth rates of juvenile queen conchs.

Site	Juvenile growth rate (mm/month)	Reference
Los Roques, Venezuela	15	Weil y Laughlin 1984
Banco Chinchorro, Mexico	10	de-Jesus-Navarrete 2003
Providence Island, Colombia	10.9	Shawl et al 2008
Belize	7.2	Gibson et al 1983
Florida, US	4.5	Brownell 1977
US Virgin Islands	4.16	Randall 1964
Cuba	3.3	Alcolado 1976
Banco Chinchorro, Mexico	3.2-1.5	de-Jesus-Navarrete 1997
The Bahamas	1.74	Ray & Stoner 1994

The shell length and the thickness of the lip are usually the two most common features used to visually discriminate between juvenile and adult conchs during surveys. Unfortunately due to the variability in growth rates, not all large conchs are sexually mature, nor are all conchs with a flared lip. Therefore the relationship between length and weight is not so simple.

Additional examples of the queen conch growth variations are:

- Samba conch: a small variety of conch with a pinkish interior and a blue exterior. These conch look old due to their thick shell. These conch may be relatively abundant in some locations (e.g. Colombia) because fishers prefer larger conch and sometimes the conch meat is darker, and therefore less preferable, than regular conch. Small-sized stocks may result from the shallow depth, generally softer substratum, and potentially lower food concentrations in sand areas or at high density (Alcolado 1976, Martin-Mora et al 1995).

- Stone conch: a large variety of conch that looks very old, have eroded spines and shell covered with sessile invertebrates. These conch are usually found in deep waters and considered be excellent for reproduction. It is believed that the meat from these individuals is tougher compared to other conchs.

For these reasons, when establishing the relationship between length and weight it is important to consider the following issues:

- To have a representative sample size from different areas under study.
- To have a representation of all ages including juveniles, pre-adults, adults and very old adults if they are present in the population.

2.5. Mobility and Connectivity

The queen conch is characterized by its slow movements and relatively small annual home range of 0.5-59.6ha, Glazer et al, 2002). It appears that they can move faster with higher water temperatures; measurements conducted in Florida indicated that mean speed in the summer (4m/day) was approximately twice that observed in the winter and spring (approximately 2 m/day) respectively (Glazer et al 2002). Acoustic tagging conducted recently in Providence Island, Colombia, indicated that juvenile conch moved within an area of 0.5-0.6km over a period of 4 months (Erick Castro, personal communication).

In a more comprehensive study using acoustic tagging, juvenile and adult queen conch were tracked over three years in Fish Bay, St. John, US Virgin Islands (Doerr and Hill. in press). They found, that 54% of tagged adults migrated out of the bay from their primary bay habitat of patchy macroalgae over a distance of 1.7km, whereas 95% of the juveniles remained inside the bay, moving an average of 4.6 m per day and occupied primarily shallow habitats dominated by seagrass.

Conchs in the Bahamas migrated from the food rich rubble community to sand habitats for reproduction (Sandt & Stoner 1992). Adult conch moved from a seagrass dominated community to a sand-algal community associated with the onset of winter in Turks and Caicos (Hesse 1979). Exhaustive surveys conducted in Quitasueño, Serrana and Roncador banks, within the San Andres archipelago, Colombia, identified the back-reef, the adjacent lagoon, and the deeper leeward pre-reef terrace as juvenile nursery habitats. Spawning areas were observed both on the northern and southern tips of the archipelago's atolls, including the "*Acropora*" reefs in Roncador´s lagoonal environment. Older adults were found in coral and sand-patch habitat as well as the deeper leeward reefs. The effects of major cuts through the forereef are believed to favor larval retention and deposition (Appeldoorn et al 2003).

Population connectivity is a product of mesoscale processes and ocean-island interactions. Conch larvae are capable of travelling long distances given their 3-week planktonic phase and their somewhat passive behavior primarily in the neuston. Lonin et al (2010) modeled queen conch larval advection in strong hydrodynamic environments (85 - 90 cm/s) within the San Andres archipelago and estimated larval speed at 168 m/day based on horizontal turbulence. They estimated that conch larvae have the potential to move more than 800km in less than 30 days with implications for conch populations further south and north. They also identified three patterns of connectivity that separated the southern, middle, and northern atolls. Differences among these atolls were confirmed using microsatellite genetic markers (Marquez et al, in press). Genetically isolated populations were identified using allozymes in Bermuda; Alacranes Reef, Mexico; Gros Islet and Vieux Fort, St. Lucia; and the Turks and Caicos (Mitton et al. 1989, Campton et al. 1992, Tello-Cetina et al. 2005). Delgado et al (2008) concluded that the Florida conch population was largely isolated based on drifter studies, plankton surveys and mesoscale circulation patterns. The ability for populations to remain isolated is an imprtant conisderation in managing a conch fishery because populations that are isolated will take longer to recover from an overfished status. These populations require conservative harvest rules when determining quotas with respect to populations that are more 'open'. Despite the increasing evidence of the isolation of some populations, the entire Caribbean region likely has some genetic exchange (Morales 2004).

Complex and dynamic oceanic circulation patterns facilitate the movement of the benthic life stages and are indispensable for the movement of the pelagic life stages. The patterns that connect juvenile and adult queen conch populations are known as demographic connectivity, and are regulated to a great extent by habitat. To understand connectivity at this scale, it is important to collect mapping information about habitat quality and distribution. This information provides a comprehensive understanding of critical landscape features that facilitate or impede movements and migrations including identification of patches and corridors (Glazer and Kidney, 2004),

At larger spatial scales, gene flow is controlled by larval dispersal and functions to define patterns of smaller populations within a larger metapopulation. Metapopulations are broadly characterized by source populations (for example, spawning populations that supply downstream populations) and sink populations (those populations that receive the larval influx); how these populations persist will affect the long-term stability and viability of the smaller populations that comprise the metapopualtion. Genetic connectivity generally measures the degree to which gene flow affects evolutionary processes within populations. Given the patchy nature of optimal conch habitat, as populations decline the ability of source populations to provide sufficient larval supplies to downstream populations becomes more jeopardized thus impacting stability at broad scales. .

2.6. Fishery Considerations

The fishery of queen conch in the wider Caribbean has been in existence since pre-Colombian times, and the intensity of this fishery exploitation has increased. Queen conchs are an easy target because: a) they prefer sandy and shallow reef areas; b) they have slow rates of movement; c) they aggregate to reproduce; and d) they have a high market value for a variety of products (Prada et al 2009). Fishermen collect the conchs in bags primarily by diving (free-diving, SCUBA, or hookah). To a lesser extent, poles with hooks, and trammel nets are also used. The meat is often extracted at sea; however, sometimes fishermen collect the shell for the curio market. Pearls are also collected if present. Commercial conch fishing is often conducted in association with commercial lobster fishing.

To determine and regulate the sustainability of the queen conch fishery, scientists rely on stock assessment models, based on fishery-dependent data. These models analyze the relationships between population abundance indices and extraction, natural mortality and recruitment functions. Unfortunately the application of these models for the queen conch fishery has proved difficult due to the following model assumptions:

- The population represent a single stock, meaning all individuals are identical (age, growth, maturation) for all ages and sizes,
- The response of populations to changes in exploitation are instantaneous,
- The stock is in equilibrium,
- Historical data on catch and fishing effort is available,
- Available data represent the totality of the catch and fishing effort,

A simplified approach to overcome these limitations is the use of fishery-independent data obtained from underwater visual censuses. Using this methodology, it is possible to determine the density and abundance of the population by examining spatial (habitat) and temporal (seasonal) variables and then applying harvest control rules. Inferences about the sustainability of the fishery would be better understood if estimates of population abundance can be established. In this regard, visual censusing provides a robust estimate for population abundance estimation, and, therefore, strategies for sustainability can be better crafted. .

Being able to identify the queen conch population abundance at the ecosystem level provides information about the potential for serial depletion, a phenomenon often attributed to conch fisheries. Serial depletion describes the progressive depletion of the fishing grounds and is often dependent on the distance from the port and the commercial importance of the species. In this model, the closest fishing grounds would be depleted first, while more distant ones would be affected later. Allocation of the fishing effort based on spatially-explicit density estimations is expected to counteract the vulnerability conch to serial depletion.

CHAPTER III. TECHNIQUES FOR UNDERWATER QUEEN CONCH SURVEYS

Objective:

At the conclusion of this chapter, trainees will improve their skills in organization, development and analysis of underwater visual census data to study queen conch stocks and to estimate sustainable levels of harvest.

3.1. Preferred Habitats

Queen conch is categorized as a specialist, being primarily herbivorous (algal/detritus feeder). As adults in large numbers they can have a major influence on benthic productivity (Stoner 1989 a, b). Young individuals, on the other hand, are micro-herbivores that feed mainly of epiphytes growing on seagrass *Thalassia testudinum*, blades. They also feed on grass detritus, macroalgae. and diatoms characteristic of sandy environments (Robertson 1961, Randall 1964, Alcolado 1976, Stoner & Waite 1991, Stoner et al. 1995).

In The Bahamas, juveniles often occur in aggregations covering 1 to 100 ha occupying habitats with specific physical and biological conditions such as in back reef areas or in the broad reef lagoons (reviewed by Stoner 2003, Appeldoorn et al 2003). With age, large juveniles and adults disperse over a wide range of habitats including seagrass meadows, algae-covered hard ground, bare sand, or rodolith beds in depths to ~35 m (Randall 1964, Stoner 2003, Gómez et al. 2005). Adult aggregations of 150-200 queen conchs have been observed within an area of approximately 30 x 100 m in open sandy habitats in the San Andres archipelago. Mating and pairing behavior were common within the aggregation (Appeldoorn et al 2003). In Florida, spawning aggregations may encompass areas in excess of 8 hectares (800 m x 100 m) (Glazer, unpublished).

Queen conch have a strong role in influencing shallow marine trophic structure and, therefore, tropical marine biodiversity in the Caribbean. Some of the more important predators include the tulip snail (*Fasciolaria tulipa*), apple murex (*Murex pomon*), octopus (*Octupus vulgaris*), spiny lobster (*Panulirus argus*), old wife (*Balistes vetula*), spotted eagle ray (*Aerobatus narinari),* tiger shark (*Galeocerdo cuvieri*, nurse shark (*Ginglymostoma cirratum*) and loggerhead turtle (*Careta careta*) (Jory and Iversen 1983, Iversen et al 1986). In release experiments using hatchery-reared conch, one of the most significant predators was the porcupine fish from the genus *Diadon*.

The preferred habitat for queen conchs includes several grades of sediment with relative low relief such as fine-grained, coarse-grained, bio-turbated sands, and rubble. The sediment is often covered with macro-algae (Randall 1964, Alcolado 1976, Stoner 1994, Stoner and Schwarte 1994, de-Jesús-Navarrete et al. 1999, Delgado 1999). Higher relief habitats such as those occupied by octocorals and hard corals embedded in sandy habitats are also important. Shallow and deep water conch populations can be found associated with the leeward slope, or over rodolith beds (Appeldoorn et al 2003, Gómez et al. 2005).

Figure 6 illustrates the various conch habitat types. In those sites that lack seagrass habitats or are considered as rare habitat, juvenile conch are commonly seen in back reef areas or in the broad reef lagoons. Considering the patchy nature of the conch habitats, it is expected that conch distribution exhibit an aggregated pattern. Glazer and Kidney (2004) hypothesized that current conch habitat associations may be an artifact of fishing pressure which has the effect of depleting conch from their preferred habitats where successful fishing requires less effort than in habitat that is less preferable.

For these reasons, when conducting queen conch underwater visual censuses, there is a need to gather information about the patchy distribution of available habitats and bathymetry (often accomplished using available benthic maps, as well as maps detailing bathymetry). Maps detailing resource use (e.g., location of the fishing grounds or the marine reserves/protected areas) represent important information to consider when conducting visual queen surveys. Aspects related to the generation and use of thematic maps including their interpretation are further discussed in the GPS (Global Position System) / GIS (Geographic Information System) section.

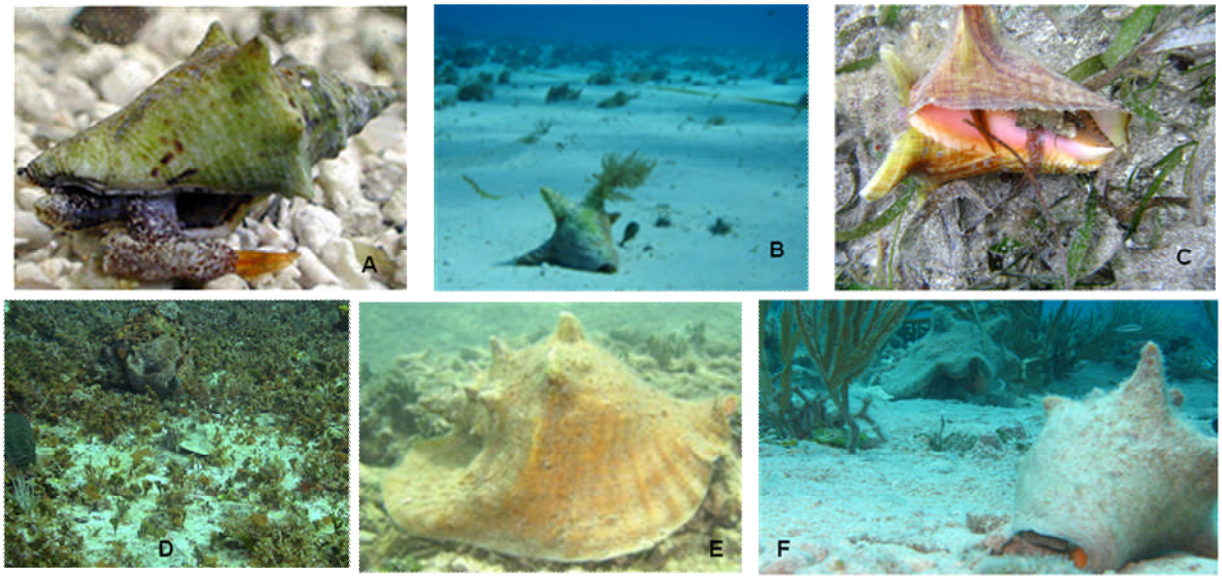

Figure 6. Examples of habitats occupied by queen conch throughout their ontogeny: A. coarse sand, B. Fine sand, C. Seagrass, D. Hard bottom, E. coral rubble, F. hard and soft corals. Pictures taken by Martha Prada, Heins Bent, Harvey Robinson, Barbara Reveles, and Megan Davis.

3.2. Use of GPS

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, it was made available for civilian use. GPS works in all weather conditions, anywhere in the world, 24 hours a day. In addition, there are other positioning systems such as The Russian Global Navigation Satellite System or GLONASS, the European Union Galileo positioning system, the Chinese Compass navigation system, and the Indian Regional Navigational Satellite System. Having a precise GPS system, surveyers can better locate the desired stations and then are able to compare spatial and temporal variations with lower errors than using other navigational approaches.

GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's precise location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Modern GPS systems with distance measurements can determine the user's position and display it on the unit's or on electronic maps.

A GPS receiver must be locked on to the signal of at least three satellites to calculate a 2D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.

Most handheld GPS receivers are accurate (25-6m), but the final accuracy will depend on the quality of the satellite signal that is received, and the availability of correction factors added to the original signal through additional antennas, differential beacons, or WAAS (Wide Area Augmentation System), among others. If WAAS correction is activated in the unit, it is possible to increase accuracy to 1-meter resolution in 97% of the cases. The accuracy of the GPS information is often based on a 50% to 60% probability, since there are factors that introduce errors (Table 2).

Table 2. Main sources and magnitude of GPS errors (from http://www.gpsinformation.org /dale/ dgps.htm)

Error	**Description**	**Value (m)**
Ionosphere	Region of the upper atmosphere, from about 85 km to 600 km altitude. It influences radio propagation to distant places on the Earth.	4.0
Clock	Time difference between internal clock and satellite clock utilized to estimate the user position. The clock varies among the GPS units.	2.1
Ephemeris	A model that estimates the GPS satellite positions and then used to estimate the user's position.	2.1
Troposphere	The non-ionized part of the atmosphere primarily composed of nitrogen and oxygen. The troposphere is a non-dispersive medium that can delay the signal traveling from the satellite to receiver.	0.7
Receiver	Varies depending on GPS unit	0.5
Multipath	Understood as the reflection of radio signals off surrounding terrain; buildings, canyon walls, hard ground, etc. These delayed signals can cause inaccuracy.	1.0
Total		**10.4**

When using a GPS unit, you need to understand the following concepts:

Datum, or the predetermined and fixed land-based references utilized to calculate the shape of the Earth and therefore to later calculate the coordinate system of a particular point of interest. There are hundreds of datums developed for specific areas. The datum WGS84 is almost identical to NAD83 and is the only reference system of global reference.

The geographic coordinate system is the system that enables you to locate a position on the Earth by a set of numbers or letters. The coordinates are often chosen such that one of the numbers represents vertical position, and two or three of the numbers represent horizontal position. In this system, the Earth is divided by imaginary lines a few kilometers away from the center except at the poles and the equator where it passes through the Earth's center. Lines joining points of the same latitude trace circles on the surface of the Earth called parallels, as they are parallel to the equator and to each other. The north pole is 90° N; the south pole is 90° S. The 0° parallel of latitude is designated the equator, the fundamental plane of all geographic coordinate systems. The equator divides the globe into Northern and Southern Hemispheres.

The projected coordinate system is the coordinate system that transforms the 3D geographic coordinate system into 2D dimensional flat projected coordinate system using mathematical formulas. Map projections usually transform coordinates into conical, cylindrical, and planar surfaces. Depending on the projection used, some distortions may be observed, thus it is recommended to use the projection that minimizes that distortion. There is a need to transform the geographic coordinate system into a projected grid when calculating geometry of the map, ie: estimation of area, perimeter, centroid, etc. Geographic Information Systems (GIS) software easily performs this kind of transformation.

3.4. Geographic Information Systems

A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all types of geographically-referenced information. You need a GPS to geo-reference your data, or to have geo-referenced maps to perform the necessary transformations. Generally, you design a GIS in response to your needs, thus several applications are utilized to make the data compatible. In a GIS you can view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.

Data for GIS can be in two formats: vector graphic or raster images. In a raster image each spatial location is associated with a pixel, or a rectangular matrix of attributes indicating for instance the color, the elevation, and ID number. Raster images are normally acquired by scanning, by a digital camera, or by a remote sensor mounted in satellites. Raster graphics are resolution dependent; they cannot scale up to an arbitrary resolution without loss of apparent quality (Figure 7).

A vector graphic uses mathematical algorithms to draw shapes using points, lines, curves, and polygons based on control points. Each of these points has a specific position on the x and y axes along with an associated attribute table. Vector data can be scaled up without losing resolution, and therefore is commonly utilized for map generation. Algorithms for manipulating and analyzing vector data are complex and may be processing intensive; however they require less memory compared to the analysis of a raster image (Figure 8).

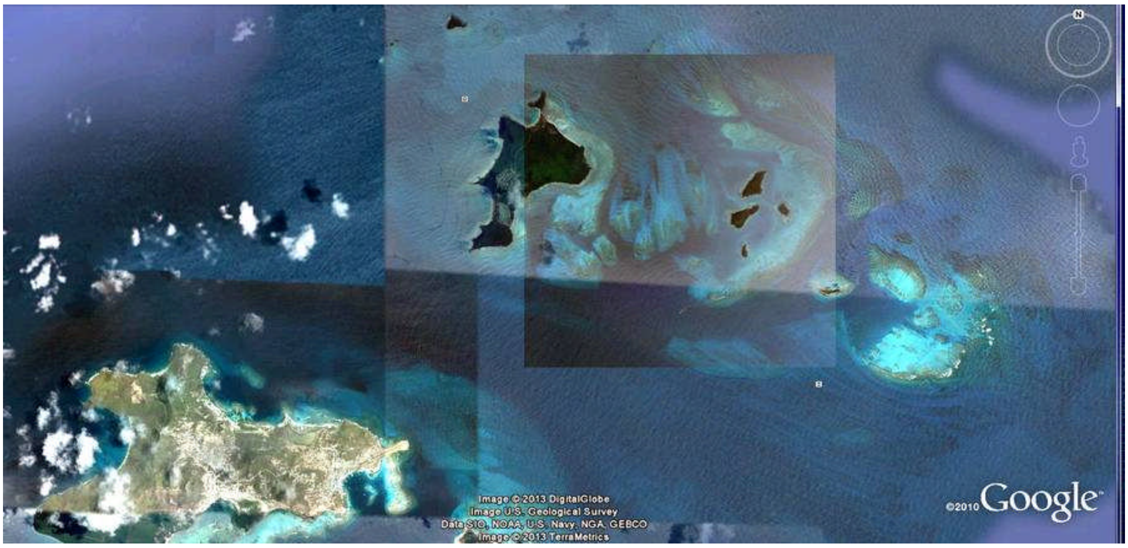

Figure 7. A raster image of the section of St Vincent and the Grenadines taken from Google Earth. Satellite imagery was taken in August 2005.

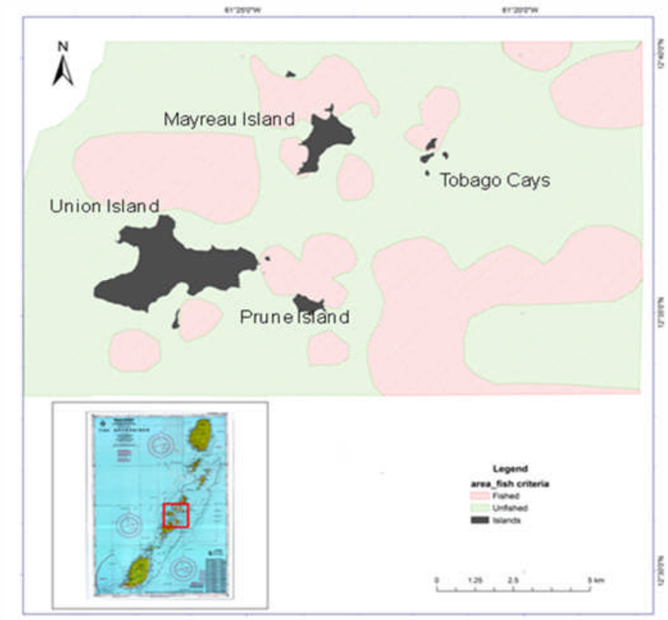

Figure 8. A vector map of the queen conch fishing grounds from a section of the St. Vincent and the Grenadines. Map generated in Arc View GIS utilizing data available in the MARSIS web database available from www.grenadinesmarsis.com

The University of Minnesota has developed a computer application that allows transfer (upload/download) data from Garmin handheld GPS receivers to GIS software through a USB/serial port connector. This is a free application call DNRGPS, and can be downloaded from http://www.dnr.state.mn.us/mis/gis/DNRGPS/DNRGPS.html. .

The use of this application facilitates and improves data quality in the survey planning, for instance in the process of uploading coordinates of the desired station locations and then downloading the coordinates of the effective field station locations. With this application, it is also possible to download waypoints, tracks, and routes from Garmin GPS and save as ArcView Shapefiles or Graphics.

Arc GIS is one of the most common GIS software packages. It is powerful but also expensive (yearly licenses are required), thus it is not always available for its broad use. Fortunately, there are open source GIS software options that can be used. Among them is the Quantum GIS (QGIS), a user friendly program from the official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, Windows and Android and supports numerous vector, raster, and database formats and functionalities. It can be downloaded from http://hub.qgis.org/projects/quantum-gis/wiki/Download. Another open source GIS is the so called gvGIS and is known for having a user-friendly interface, being able to access the most common formats as both vectors and rasters. This software can be downloaded from http://www.gvsig.org/web/home/gvsighome /view?set_language=en.

The underwater census for estimation of the queen conch abundance will require GIS applications to: a) develop stratified sampling protocols; b) determination of spatial distribution of conch juvenile and adult densities at the various strata selected; c) establish trends of conch abundance.

3.5. Sampling Design Considerations

As presented by Ehrhardt & Valle (2008), estimation of queen conch population abundance can be performed utilizing several protocols as follows:

Random protocol: This option considers stations selected randomly within the study area. This approach is not recommended since it is well known that conch aggregate in specific habitats and depth strata. The protocol is simple, and the calculations are also simple, however it is a method of low efficiency and precision.

Systematic protocol: This option considers equidistance and pre-defined distances among stations. Randomness is introducing when selecting the first station. Using this protocol, the entire area can be surveyed, but is possible to have data gaps depending on the location characteristics such as patchy habitat distribution, or the inclusion of sites beyond diving limits. Calculation of the population mean can be biased, which can be counteracted with a large number of stations. Another limitation is that there is no formula for calculating variances.

Stratified random protocol: This option allows the selection of stations using criteria affecting the abundance of the conch populations such as the spatial distribution of habitats, bathymetry, the location of fishing grounds, or the locations and patterns of protected areas. The applicability of this approach relies on the availability of the spatial information related to these criteria. Stations are apportioned randomaly to the defined strata. When the study area lacks habitat maps, nautical charts are useful to define depth strata and aerial photographs or Google Earth images are useful to help define habitats in shallow waters. Experienced fishers can provide useful knowledge for complementing maps needed for identification of strata to be surveyed. It is expected that using this protocol will reduce overall variability, calculations of population mean will utilize weighted formulas.

Stratified random with replication protocol: Similar to the stratified random protocols, but includes additional stations randomly located within each strata, accounting for variability in populations that are not homogeneously distributed. For instance, the second order of stations can be allocated within conch aggregations.

Independent of the selected protocol, at each station the diver will count and measure queen conchs within a known area, either in a belt transect or in a rectangular or circular quadrat (Figures 9-10). The extension of the sampled area will depend on the local environmental characteristics. Usually belt transects are applied to broad shelf areas, whereas quadrats are applied to narrow shelf areas. It is expected that the areas surveyed will be around 500m^2 or more.

For larger areas, divers may be towed by vessels or use scooters to cover, especially in low density populations such as when conch populations have been decimated.

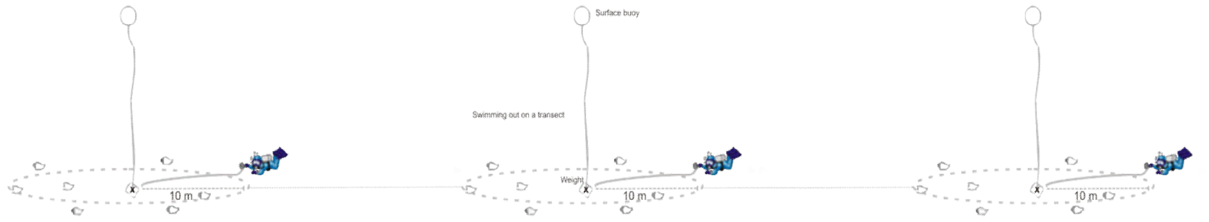

Figure 9. An example of simultaneous circular quadrat carried out by three divers. The circle size will vary depending on the site characteristics and the sampling design. Drawing by Diana Prada.

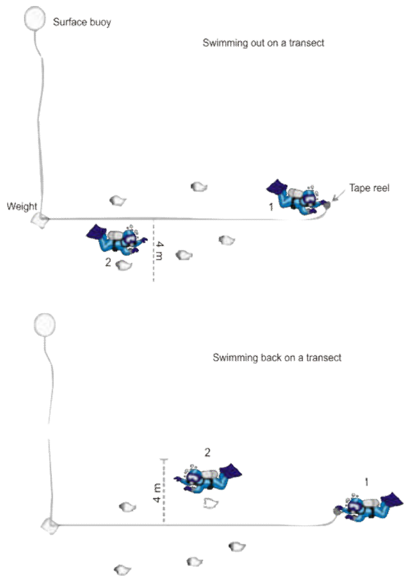

Figure 10. A belt transect surveyed by two divers. The length and width of the transect will vary depending on the site characteristics and the sampling design. Drawing by Diana Prada.

Glazer (1999) developed a protocol for sampling inside conch aggregations based on belt transects. Initially, a primary tape (usually 100m) is laid along a margin of the aggregation. Five randomly-placed belt transects extend 100m perpendicular from the primary tape. The belt transects bisect the aggregation and all conch are counted 1-m either side of each belt (2m total width). Data recorded includes size of conch (length for juveniles and lip thickness for adults), habitat along the belt, habitat that each conch occupies, location along the belt where the conch is found, and reproductive activity (mating and/or spawning.) The area of the aggregation is determined by swimming the perimeter of the aggregation using a GPS and using these points in a GIS to determine the area occupied by the aggregation. The product of the density estimations and the area of the aggregations provide an estimation of ht etotal abundance of both adults and juveniles. The relationship between reproductive density and overall density is enumerated to help understand Allee effects in the Florida population.

During conch visual census, the diver at minimum should measure the following morphological features (Figure 11):

- Siphonal length or the length from the apex of the spire to the end of the siphonal canal using large calipers.
- Lip thickness or the thickness of the flared lip measured at the closest place to the last conch spire, using a small caliper.

It is expected that the combination of these two measurements can help discriminate between juvenile and adults conch. Initially, conch having a siphonal length larger than 200-220mm were believed to be adults; subsequently the concept of lip thickness was introduced. Adults (characterized by maturation of the gonads) are now defined by a minimum lip thickness of 5mm. More recent studies are reporting that sexual maturity is achieved when conch attain lip thickness. This corresponds to roughly 6-10 months after the initial formation of the flared lip (Egan 1985, Aldana-Aranda and Frenkiel 2005, Stoner et al 2012).

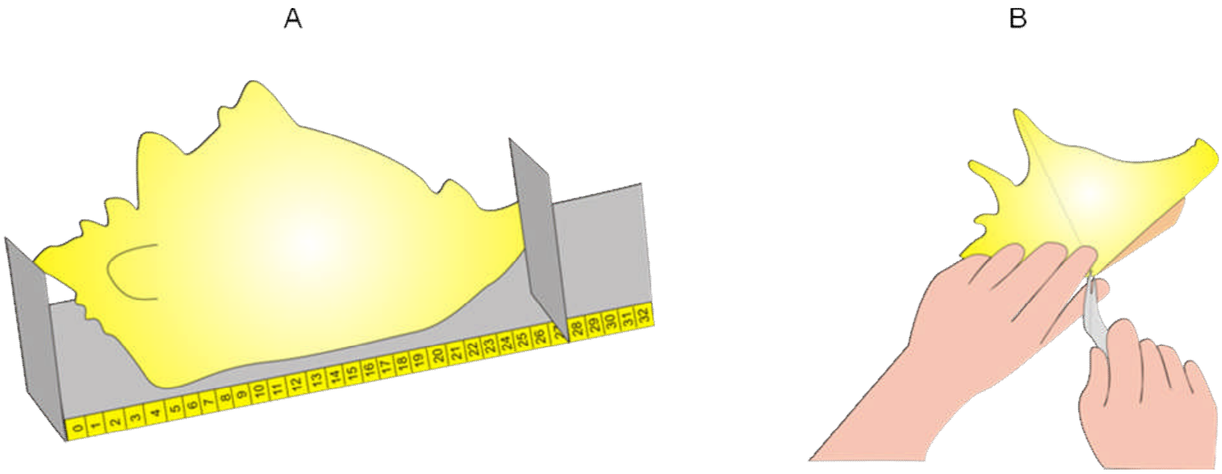

Figure 11. The two most common morphometric parameters for estimating the age of queen conch: A. Siphonal length, B. Lip thickness. Drawing by Diana Prada.

During underwater visual surveys, additional information on ecosystem characteristics may be collected, including for instance habitat type or quality. Data collection of other organisms may facilitate the examination of biodiversity. Conch tissues can be collected for genetic analyses.

Other information can also be collected from the sampling vessel including plankton trawls for larval conch abundance and/or distribution (or other components of the plankton). At a minimum, the following data should be noted during these surveys: a) observer name or code; b) Date, c) site name and GPS coordinates; d) average depth of the site; e) length or number of transects; e) siphonal length and lip thickness for every conch inside the transect; and f) predominant habitat type for the transect. Additional information may also be beneficial when examining the data. These include a) the estimation of conch presence or abundance outside the transect; b) identification of other conch species, and c) environmental characteristics such as water temperature, currents, weather conditions. These additional data can be useful in providing overall ecosystem-based information.

The relationship between conch length and weight is important when determining the overall biomass of the population. For this reason, other relevant information that could be collected is related to the conch length and conch weight (the entire animal). This relationship between these two parameters is ncessary to determine morphological population characteristics and the growth equation parameters (the coefficient and the exponent included in the mathematical function describing the relationship between length and weight). When there is no conch length-weight relationship for the survey region, or when the relationship exists but has not being updated for several decades, re-estimation of those parameters is recommended. In this case, researchers need to collect a broad sample of conch including juveniles and adults, thus providing a comprehensive representation of the population thereby reducing the confidence limits associated with the parameters.

Conch measurements obtained by diving require experienced divers that can locate all conch inside the sampled area including buried animals while adhering to safe-diving procedures. Annex 1 is presents standards that promote safe diving procedures and protocols used for scientific diving institutions in the U.S.

Information about queen conch located beyond the safe-diving limits of SCUBA diving using ambient air (25-30m deep) need different approaches (Figure 13). One can be the use of a re-breather system. This is a system that recycles exhaled carbon dioxide by adding oxygen in a closed or semi-closed circuit. The re-breather system utilizes a mixture of gasses (oxygen, helium, nitrogen) to allow for deeper diving. A diver with a re-breather can usually go as deep as 200m, thus exceeding even the deepest sites within which conch are believed to inhabit (approximately 100-120m deep). The downside of this approach is the cost of the system, including training, along with the limited time divers have depending on the working depth.

Another approach is the use of a towed camera that can record video/photograph imagery along with GPS information. This approach provides real-time observation as well as an archival record for subsequent analysis. There are a variety of these towed system among them are:

Video cameras: such as Sea Viewer (www.seaviewer.com), a custom-built professional-quality camera system which can be used to take snapshots of one location or used for fast-trolling. These systems are available with optional LED lights, GPS video overlays and video recorders that are used in many different underwater applications. This system has been employed in benthic surveys of habitat in the Grenadines. It is also currently being employed in surveying deepwater conch populations in Florida.

Remote Operated Vehicles (ROV): a tethered underwater robot tethered via a communications cable to the surface. The system consists of cables that carry electrical power, video and data signals back and forth between the operator and the vehicle. Most ROVs are equipped with at least a video camera and lights. Additional equipment is commonly added to expand the vehicle’s capabilities. These may include sonar, magnetometers, a still camera, a manipulator or cutting arm, water samplers, and instruments that measure water clarity, light penetration and temperature (Figure 12).

Autonomous Underwater Vehicles (AUV): This is a similar system to an ROV. In this case, the vehicle navigates underwater without requiring input from an operator. Hundreds of different AUVs have been designed over the past 50 or so, but only a few companies sell vehicles in significant numbers, including Kongsberg Maritime, Hydroid, Bluefin Robotics, Teledyne Gavia, and International Submarine Engineering (ISE) Ltd. AUVs carry sensors to navigate autonomously and map features of the ocean. Typical sensors include compasses, depth sensors, sidescan and other sonars, magnetometers, thermistors and conductivity probes (Figure 12).

Two parallel underwater laser pointers can be added to the video system in a way that positions the conch in the center of the image, allowing for estimation of size. This is a distinct advantage over towed cameras. The laser photogrammetric estimations are more precise than visual estimates. Laser pointers are usually at sufficiently low power output of <5 mW which means that short, accidental exposure does not damage the eye (Rhoner et al 2011).

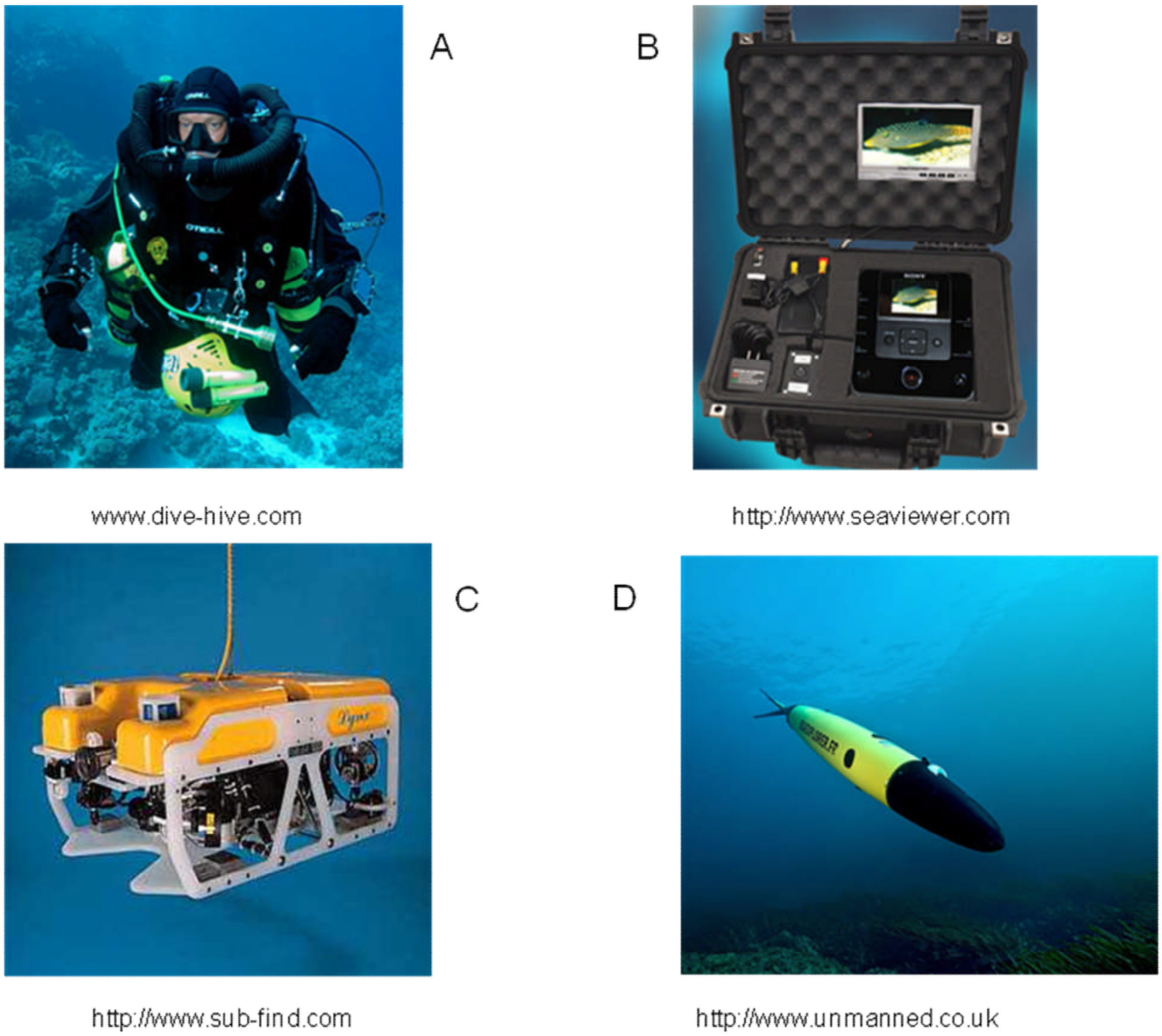

Figure 12. Examples of available technology for observing deep water fauna: A. Re-breather, B. Towed underwater video camera, C. Remote Operated Vehicle, D. Autonomous Underwater Vehicle.

3.6. Data Analysis

Once the underwater visual census has been concluded and the data has been entered and proofread, the next step is the process of data analysis to estimate sustainable levels of queen conch exploitation. This analysis involves a series of procedures and calculations that are presented below: These steps were adapted from analyses conducted in the Grenadines yet they have broad applicability.

1. Using Microsoft Excel®, select the entire data sheet, sorted from largest to smallest, thus ensuring that stations with no conch will be located at the end.
2. Create two new columns; one for juvenile conch and another adult conch. To discriminate between juvenile and adult conch, two criteria can be utilized: the LT (lip thickness) and the SL (shiphonal length). Based on the LT criterion, recent studies have recommended that conch may still be juveniles if their lip thickness is < 15mm (Egan 1985, Aldana-Aranda & Frenkiel 2005,

Avila-Poveda & Baqueiro-Cárdenas 2006). Alternatively, if SL is utilized, the average legal minimum size can be used assuming they are based on the level at which the 50% of the population have reproduced at least once (Table 2). Therefore, adult conch should have minimum 19.6 cm SL (the average across all locations in Table 2). It is recommended to add 1-cm to this value to incorporate a 'precautionary' buffer. Excel filters, pivot tables or logical functions can facilitate this process of identifying juvenile or adult conch in the population.

Table 2. Summary of the minimum shell length stated in current fishing regulations.

Country	Fishing Regulation	Size (cm)
Antigua and Barbuda	Fisheries Act No 14 of 1983 Fisheries Regulation No 10 of 1990 Fisheries Act No 22 of 2006	18
Belize	Fishery Regulations of 2005	18
British Virgin Islands	Fisheries Regulations of 2003 Amended in 2002; 2007	17.8
Cuba		20
Dominican Republic	Law 64-00, Decree 833-03 of 2003, Law 307 of 2004	18
Grenada	Fisheries (Amendment) Regulations	18
Honduras	Ministerial Agreement 820/ 2003, 103/2005, 391/ 2006	22
Jamaica	Fishing Industry Act of 1975; 1976	22
Martinique	Regulation 994296	22
Nicaragua	Decree DGRN-PA-No 407-05 of 2005	20
Puerto Rico	Reglamento de Pesca de Puerto Rico 2010 No 7949	22.9
St Kitts/Nevis	Fisheries Regulation No 11 of 1995	18
St Lucia	Fisheries Regulation No 67 of 1987; No 9 of 1994	18
St Vincent/Grenadines	Statutory Rules and Orders Act Part 4 Sec 18 of 1986	18
Turks and Caicos		18
US Virgin Islands		22.9
Average		**19.6**

3. Using the Excel pivot table tool, in a new worksheet generate a Station Summary Matrix containing the following columns: site, lat, lon, X, Y, date, area surveyed per station, total conch, no. adults, and no. juveniles. Make sure that any label in the worksheet is larger than 6 characters.
4. Estimate the conch density per station by dividing the total number of conch by the total area surveyed for adult, juvenile and total conch. The following formula should be applied to estimate density:

$d_s = X_s / a_s$

Where:

x_s = Total number of conch found in the station

a_s = Total area surveyed per station

Remember, conch density will be calculated as ind/ha. Thus, there is need to express area in ha, for which you need to multiply values in m^2 given by the GIS by 10000. Save this file as a text file (CVS or comma delimited for instance).

5. Open QGIS and import the Station Summary Matrix text file from the layer menu using the Add Delimited Text Layer function. Choose the appropriate format of the text file. Save this project.
6. Generate a point thematic map to illustrate the conch abundance. Use graduated symbols and colors in a way the information can be easily interpreted with respect to density, for example.
7. Add background polygons/raster maps to the GIS project (e.g., MPA spatial layer, layer representing fishing zones, Google image.) Select the combination that is more illustrative and easy to understand. You now have the first product for your report.
8. Calculate the total area in the MPA layer (ha), for protected and not protected strata within the GIS.
9. Continue with a spatial join in QGIS, in the Data Management Tool menu. The target vector will be your point file, the join vector layer will be your MPA map. Create a new file and make sure to select "keep all records" in the output table option. Now you are ready to continue the analysis in Excel. (MPA will be the strata for the analysis, since there is not a detailed habitat map).
10. Once again, open the Excel file and call the new join file. Now every station has in addition information about stratum under examination.
11. Group the conch density by sampling strata, and, for each stratum, calculate the descriptive statistics. These parameters include average, variance, standard errors, confidence limits of the estimation, etc. Excel or any statistical program can easily perform these calculations.
12. Extrapolate densities from sampling stations to the entire surveyed area. To do this you will need to have the total area by stratum (previously calculated in the GIS application). Once area by stratum is obtained, there is need to estimate the proportion of each stratum area to calculate weighted densities, applying the following formula:

$$D = \Sigma\, d_e \,*\, (A_e / A)$$

Where:

A_e = Total area by stratum

A = Total area being studied.

d_e = Density by stratum

13. The sum of the weighted densities multiplied by the total area will provide estimates of the total population abundance.
14. Determination of overall fishing potential will be now examined against pre-established density reference points. The latest recommendations are based on the population density greater than or equal to 100 conch/ha or higher if the spawning stock is included in the survey. This recommendation was adopted by the Queen Conch Expert Workshop, by the WECAF Queen Conch Working Group, and by CoP16, resolution "Regional Cooperation on the Queen Conch Management of and Trade". Lower densities indicate significant risk that reproduction, and hence recruitment will be impaired, and therefore special management measurements might be required. This reference point may change at different locations depending on site-specific information (e.g., reproduction at density). In any case, fishing is not advised if adult densities are less than 50 conch /ha based upon a minimum threshold previously identified for successful queen conch reproduction (Stoner and Ray-Culp 2000). See more information about this recommendation in Medley (2005).

15. In those situations where queen conch population densities exceed the minimum threshold values detailed in 14 above, 8% of the estimated mean or median fishable biomass can be used to set a precautionary sustainable yield. To estimate the conch population biomass, it is necessary to generate a histogram with various conch size classes and then applying the following formula:

Biomass = ΣAL * WL

Where:

AL = abundance within each size class (total length)
WL = average weight within a given size class

To calculate the value of the WL, it is necessary to apply the length-weight relationship: Weight = $a*b^{Length}$, or, ln(Weight) = a + b*ln(Length). Table 3 presents parameters estimated for this relationship in several lcoations.

Table 3. Parameters for the relationship Weight-length at various Caribbean locations

Place	**Constant (a)**	**Coefficient (b)**	**Reference**
La Parguera, juveniles, Puerto Rico	-2.533	3.484	Appeldoorn 1991
Isla Caja de Muertos, juveniles, Puerto Rico	-2.232	3.200	
La Parguera, adults, Puerto Rico	-1.510	2.804	
Isla Caja de Muertos, adults, Puerto Rico	-1.590	2.783	
Vieques Island, adults, Puerto Rico	-3.708	2.583	
Pedro Bank, Jamaica	-4.29	3.14	Tewfik 1991

It is important to recognize that fishable biomass will only include conch in those size-classes within which fishing is allowed. Conch in size-classes for which fishing is prohibited are not considered part of the fishable biomass. In many locations, juvenile conch are not permitted to be harvested and would therefore not be considered as part of the fishable biomass.

16. Once the total conch biomass is estimated, the 8% harvest control rule can be applied, also following recommendations in the Regional Cooperation on the Queen Conch Expert Workshop. Additional restrictions should be applied to this calculation based on site-specific conditions (for example, how 'open' or 'closed' the population is).

    Total Allowable Catch (TAC) will be the final recommendation for the fisheries managers and needs to incorporate a meat conversion factor for the different meat weight. The conversion factors are required because meat is trimmed to remove the intestines and other internal organs and the peeling of the darker portion of the outer "skin" to various levels depending on the consumer demands or cultural preferences (clean at 50, 65, 85 or 100%). This approach accounts for local consumption, and to define the final export quota.

    Initial processing is completed by the fishermen, but final prepration for export is usually completed at a processing plant. The processing of the meat therefore requires a conversion factor in order to determine the real level of extraction at the population level as stated by Aspra et al (2009). While overall consensus about how the conversion factors can be used and applied either for the entire Caribbean or for sub-regions, these authors proposed a conversion factor as presented in Table 4.

Table 4. Proposed conversion factors for queen conch meat to nominal weight. From Aspra et al 2009.

Processing grade	Conversion factor to nominal weight
Dirty	5.7
50% clean	9.5
85% clean	13.7
100%	16.3

17. The estimation of the final quota will need to incorporate additional restrictions depending on several criteria. One of them is the extent of the fishing bank. If the bank area is small, the potential to sustain fishing is reduced, thus requiring a downward adjustment of the estimated fishable biomass. Another aspect is the dependence of the conch population from external larval supply, a phenomenon which is difficult to validate. A number of pieces of evidence can be used to make this determination (see, for example, Delgado et al., 2008). Alternatively, the final quota can be adjusted upward if there are additional conservation measures such as the implementation of marine reserves with healthy, reproducing queen conch in dense aggregations. Additionally, a variety of conch ages should be present. The use of these strategies are all examples of good application of the precautionary approach towards sustainable fishing.
18. Once a final TAC is developed, fishery managers needs to calculate the local consumption to ensure that it is incorporated into the final export quota. International trade in queen conch is subject to CITES review; therefore, it is important to consider that CITES examines how each Party define its export quotas and if the Non-detriment findings are applied in the process.

3.7. Additional information

Geometric Morphometry

Additional queen conch population characterization can be obtained through geometric morphometry. This is a low-cost technique that facilitates analyzing phenotypic differences by looking at the variability of shapes based on reference points. The approach uses polygons centroid distances using the free software "**C**ollection of **L**andmarks for **I**dentification and **C**haracterization" or CLIC package (http://www.mpl.ird.fr/morphometrics) developed by J.-P. Dujardin from Institut de Recherche pour le Développment (IRD) in France. To confirm statistical significance of the results, additional statistical analyses using ANOVAs or multivariate analyses might be necessary. This modern morphometric tool can provide information on queen conch population growth or differences between ontogenetic stages. There are other free software packages such as TpsDig, TpsRelw, TpsReg, TpsUtil, TpsTr available from http://life.bio.sunysb.edu/morph/ can be also used for this type of analysis.

Reference points are obtained from a representative number of queen conch photographs that should be taken with the same focal distance, if possible with the same camera, and over flat surfaces, thus ensuring standardization. A total of 10 reference points for each picture is highly recommended (Edna Marquez, personal communication). One example of the use of geometric morphometry is presented in Figure 13.

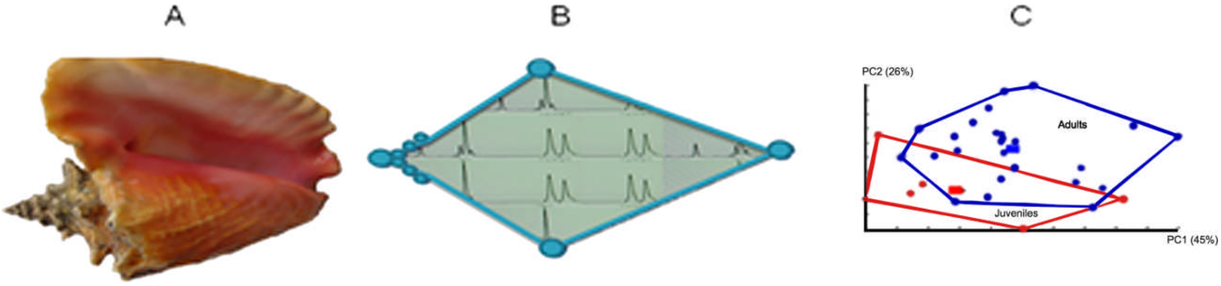

Figure 13. Use of geometric morphometry to estimate growth differences between adults and juveniles of queen conch populations in the San Andres archipelago, Colombia. Provided by Edna Marquez unpublished. A. Basic queen conch photograph, B. Reference points and polygon generation, C. Comparison of the results between juvenile and adults.

Plankton

Plankton samples can be collected during the field surveys and these samples provide additional information on the presence/absence, density, and abundance of veligers. The collection of the samples requires a 202 micron plankton net with a flow-meter attached in the mouth of the net (Delgado et al 2008). The flow-meter measures the volume of water that passes into the net thus providing density estimates of conch larvae (number of larvae/m^3). Depending on the local conditions, the plankton net can be towed between 15 – 30 min at low speed. The samples should be preserved in 70% alcohol or 10% formalin. Analysis of plankton samples continues at the laboratory where experts identify and quantify the plankton community. The use of plankton information is important to verify conch reproduction and to infer sources of conch larvae recruiting to the local population (for an application of this analysis, see Delgado et al 2008).

As previously discussed, the determination of a quota to sustain a queen conch stock may depend on the source of the larvae providing recruits to the population. If most larvae are coming from sources outside the stock, more relaxed regulations may be sufficient. However, if the source of larvae are primarily from the local population, regulations and/or quotas will need to be very conservative to ensure sustainability. Plankton sampling, genetic analyses, hydrographical considerations, and the time required for the recovery of a population may all serve as proxies for how 'open' or 'closed' a population is and, consequently, how conservative management must be. For example, in Florida, queen conch plankton sampling, drift vial studies, remote sensing information, and the time to for the population to recover suggest that the population may be closed and therefore more conservative policies are necessary to ensure the long-term sustainability of the population (Delgado et al 2008).

Genetics

There are currently several type of genetic approaches that can be used to examine the composition and origin of queen conch populations. These methods fall into two broad categories: DNA-based (e.g., microsatellites) and proteins (e.g., allozymes). In general, the methods that examines proteins is much less expensive but it is also much more coarse. DNA-based techniques have become less expensive and are more accessible due to the rapidly developing advancement in genetic techniques and tools. Prior to the wide use of these techniques, it was widely believed that larval transport facilitated the extensive exchange of genetic material over large distances and, therefore, the region-wide populations was well-mixed and uniform. Current interpretation of the results of a number of studies are contradicting those conclusions. For instance, in the case of San Andres archipelago, Marquez et al (in press) identified three different genetically distinct populations (Figure 14) that were explained by patterns in oceanographic (Landínez-García et al. 2009).

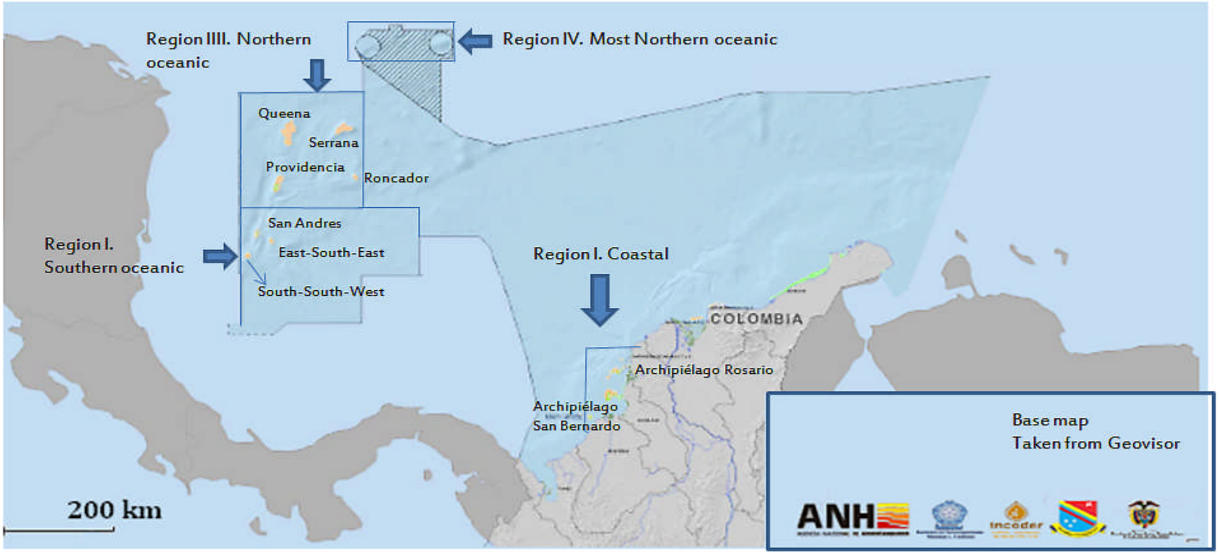

Figure 14. Location of different banks within the San Andres Archipelago, where several genetic and morphometric studies have been conducted. Marquez et al (in Press).

CHAPTER IV. ADDITIONAL CONSIDERATIONS ON PLANNING AND SURVEY DEVELOPMENT

Objective:

At the completion of this chapter, trainees will be in better position to plan and develop a scientific survey program to study the spatial distribution and abundance of queen conch and of integrating criteria to avoid negative outcomes.

4.1. Introduction to developing a survey program

Information presented in this section complements the theoretical concepts developed in previous chapters, particularly related to the recommendations needed to plan, organize and develop queen conch visual surveys. Therefore, this chapter includes recommendations related to the selection of a team, identification of their role, and decisions about the survey approach following the steps detailed in Figure 15.

Survey planning usually begins with the institutional (fishery or conservation agency) decision to conduct a scientific expedition and to clearly establishes its objective(s). The early establishment of achievable objectives with available resources is critical for the clarity of purpose within the survey team, for ensuring that the priorities of the funding agency are addressed, and to achieve and maintain the broad support of the resource users and the general public. For example, divers need to follow the planned protocol, and not diverge to secondary objectives; and boat captains need to put divers in the correct locations. Data should be backed-up without exception, safe-diving should always be exercised, and statistical and GIS input about number and location of the stations should be performed correctly.

Achievable objectives will be based on the availability of financial, technical, and human resources, and the ability to leverage these resources by developing effective partnerships with local, national or international partners. Timelines should be identified early in the planning process.

A well-developed team is critical to ensure an effective sampling program. Therefore, emphasis should be placed on the selection of the expedition coordinators including a chief scientist, logistical coordinator, divemaster, boat captain, and a group that comprises the core survey-planning team. The core team is responsible for identifying appropriate field work methodologies, achievable timelines, and protocols built on a full review of all available information concerning the area of interest. Local fishers may also be invaluable when developing a robust and comprehensive team because their knowledge of the spatial distribution is invaluable when identifying areas to be surveyed.

Even though the team should have developed approaches for the surveys, they must also be sufficiently flexible for issues that may arise. For example, maps may not accurately reflect bathymetry thus making safe-diving at the predetermined site impossible. Additionally, inclement weather may impact the timeline thus necessitating changes in sampling schedules. The goal should be the need to make ad hoc changes to the sampling program during the survey. In general, anticipating problems may incrase the ability to improvise efficiently during the surveys.

It is recommended to have this plan in writing, and give a copy to every individual participating in the survey; sometimes this document is required to obtain necessary survey permits.

The survey team

- Fisheries or conservation agencies (define objectives, time tables, funding sources, and other potential partners)
- Chief scientist (person in charge of the scientific aspects of the survey)
- Logistics coordinator (person in charge of the survey logistics)
- Dive coordinator (person qualifyied to supervise diving, responsible for safety, and provide dive logistics)
- Boat captain (person responsible for all navigation and nautical support) during the field work)
- Observers (divers qualifed for data collection and managing of the dive gears or any tool/equipment utilized in the survey). Conch commercial fishers are recommended.
- Data analysis group (lead scientist along with technicians or observers (if different). An independent advisor is highly recommeneded.
- GIS technician and a statistician if the expertise is not the the data analysis group.
- Communication coordinator (person that will inform the survey information to the broad

The survey preparation

- Aggreement on sampling method and extension of area cover depending on funding and partnerships
- Selection of working platform, the entire survey personnel, and all of the field strategies and protocols
- Elaboration of a detailed working plan document.
- Adquiring needed equipment and supplies for the field work
- Preparation and revision of diving equipment, and every equipment that will be utilized in the training
- Safety training/refreshment
- Processing sicientific permits, if necesary
- Aggree on communication protocols among all coordinators, lead and communication personel

The survey development

- Dayly work plan and coordination among boat captain, lead scientist, logistic coordinator and lead dive
- Observers digitize dayly data, download GPS, picutres and compile information and set up a data back up system
- Dive coordinator revise and verify dive gears and make adjustments when necessary
- Daily communication coordinator

Figure 15. Steps in planning and conducting a fisheries independent survey program for queen conch. The roles and functions of various members of the conch survey team are associated with the specific activities.

4.2. The survey team

The development of an underwater visual census requires assembling a multi-disciplinary team with expertise and experience relevant to the survey program priorities. The survey development process consists of three phases: planning, development, and data analysis and reporting and it is important to ensure that individuals who are familiar with each stage are part of the team. The ability to interact and communicate within a group is a concern mainly during the field work phase, and it is key in the successful completion of the mission. Remember people will be onboard of a sampling platform (sometimes small), working hard during consecutive days and perhaps and under risky conditions. These factors may generate special reactions and emotions that need to keep under control.

As presented in Figure 15, the entire survey team with eight principal roles: The chief scientist, the logistics coordinator, the dive coordinator (or divemaster), the boat captain, the observers, the data analysis group the GIS and Statistical experts, and the communication coordinator. Each role particular responsibilities as described below.

Chief scientist: The Chief Scientist is the person responsible for all the scientific work of the survey. Additionally, this person or persons should offer guidance and training for the working group. The chief scientist will respond to government or private institutions and is responsible for the overall data analysis and reporting. To assume these responsibilities the chief scientist should be qualified on several aspects: broad scientific knowledge, experience to attend field work eventualities, good communication skills and amenable to consult with relevant personnel, and various sources of information when necessary. The chief scientist is in charge of defining the appropriate survey data storage protocols.

Logistics coordinator: This is the person in charge of the logistics for the survey, during all three phases: planning, developing and analysis. Logistic is a broad term that refers to issues including travel, accommodations, availability of food, ensuring dive supplies are available and have been ordered as requested by the chief scientist, among others. The logistics coordinator interacts with the scientific personnel and the operations personnel.

Dive coordinator: This person needs to be a certified dive instructor or divemaster from an accredited diving accreditation organization. Preferably, they will be familiar with the area to be surveyed. They will ensure that all necessary dive gear is available and appropriate for he surveys approaches. Most importantly, they are responsible for ensuring that safe diving operations are conducted. In larger operations, this person is responsible for ensuring that the equipment is maintained and safe. They should record dive profiles including air consumption. It is highly beneficial if the divemaster is familiar with scientific diving and the needs to sometime make changes to dive plans as conditions warrant those changes.

The Dive Operator is often the dive shop who contracts the vessels and provides a captain for these operations. This person should produce a dive safety plan identifying diving protocols in case of any emergency, actions taken to maintain safety during the survey, and include the contact information for immediately communicating rescue resources available in the area. All divers should be insured in the case of an emergency (special dive insurance is available). Dive insurance providers needs to be contacted ahead, thus the dive safety protocol can be properly revised and checked.

Field personnel: These are the certified divers responsible for the actual data collection. Scientific divers must be comfortable and be able to: a) work long periods in the water; b)identify queen conch including both adults and juveniles and take high-quality data;, c) use dive equipment/instruments, d) maintain buoyancy to ensure sampling efficiency, and e) know how to respond to changing weather conditions.

The divers are responsible for entering their own data into the computer, and to conduct quality control procedures prior to beginning the data analysis phase (i.e., proof read the data). A valuable plus of the diver is their knowledge in taking good underwater photographs. It is also advisable that they use their own equipment or have time to familiarize themselves with the equipment they will use, and how to maintain it is safe working condition. In those cases where advanced underwater survey approaches are employed (e.g., mixed gas diving), specific skills and training are absolutely necessary. If the survey uses deep diving, divers most have specific training and enough experiences to work under those conditions. Surveys employing using underwater video approaches may not need to dive much, but they must be comfortable with technical equipment and video equipment. It is advised that all participants are trained in first aid, cardio-pulmonary resuscitation, and oxygen administration.

Data Analysis Team: This is a group lead by the chief scientist and comprised of a good representation of the field personnel, along with other biologists and GIS and Statistical experts whose will be responsible for the analysis and reporting phase of the project. In many cases, it may be advisable to add an external scientific advisor who is familiar with developing the appropriate sampling methods prior to the survey, and consult on the appropriate statistical analyses after the surveys. The independent advisor can help in the verification of conceptual issues, data treatments and analysis, making sure the best available information is always utilized. The data analysis group should generate management scenarios and provide recommendations that have robust precautionary principles integrated into the analyses. Several proprietary computer software programs can be used for this purpose including the open source program open refine (http://openrefine.org/).

GIS and Statistical Experts: From the analysis group, the participation of a statistician is of great relevance. This expert should have a strong background in sampling methods and statistical analysis and invaluable in setting up the sampling design for maximum efficiency and to reduce variability. This person can use data from surveys either in the area where the program will be conducted, or data from other locations, to determine sample size and sample protocols.

The GIS specialist will participate in the spatial analysis, and generate maps needed to graphically present results, thus facilitating the interpretations and conclusions of the results. In some cases, this person can also advise on additional computer issues and software formatting, relevant when using different operating systems, software versions, or specific software demands.

Communications coordinator: The role of a communication coordinator is to contribute to the survey divulgation, by revising the wording utilized in the scientific reports, thus they can be easily understood for the general public. This step is important especially when delivering the survey conclusions and recommendations to the people taking final decisions on resource management, and consequently planning actions needed to accommodate the survey recommendations. The communication coordinator is also responsible in the establishment of the communication protocols during the field work.

The fishery/conservation lead authority and their partners are the authority (ies) that initially determine: Because of the great responsibility involved in at this level, the most appropriated strategy is to assemblage a strong partnership locally, nationally or internationally if necessary.

Once data analysis is concluded, and prior to draw final conclusions and recommendations, a workshop with the people having good local knowledge of conch distribution and abundance, is highly recommended. This strategy opens the door to share results between scientific protocols and the traditional knowledge, providing an additional space for results analysis and to increase trust among these two groups. .

4.3. Survey preparation

Several issues are considered in this section. The first one is related to the survey methodology.

The survey methodology should be based on a number of practical considerations besides those based on statistical design. Perhaps most importantly, the depth of the surveys will determine what methods are practical (Figure 16). Beyond safe diving depths will require either cameras or divers trained in deep diving techniques as described in previous sections. The determination of safe-diving depths should be made by the dive coordinator in association with the chief scientist.

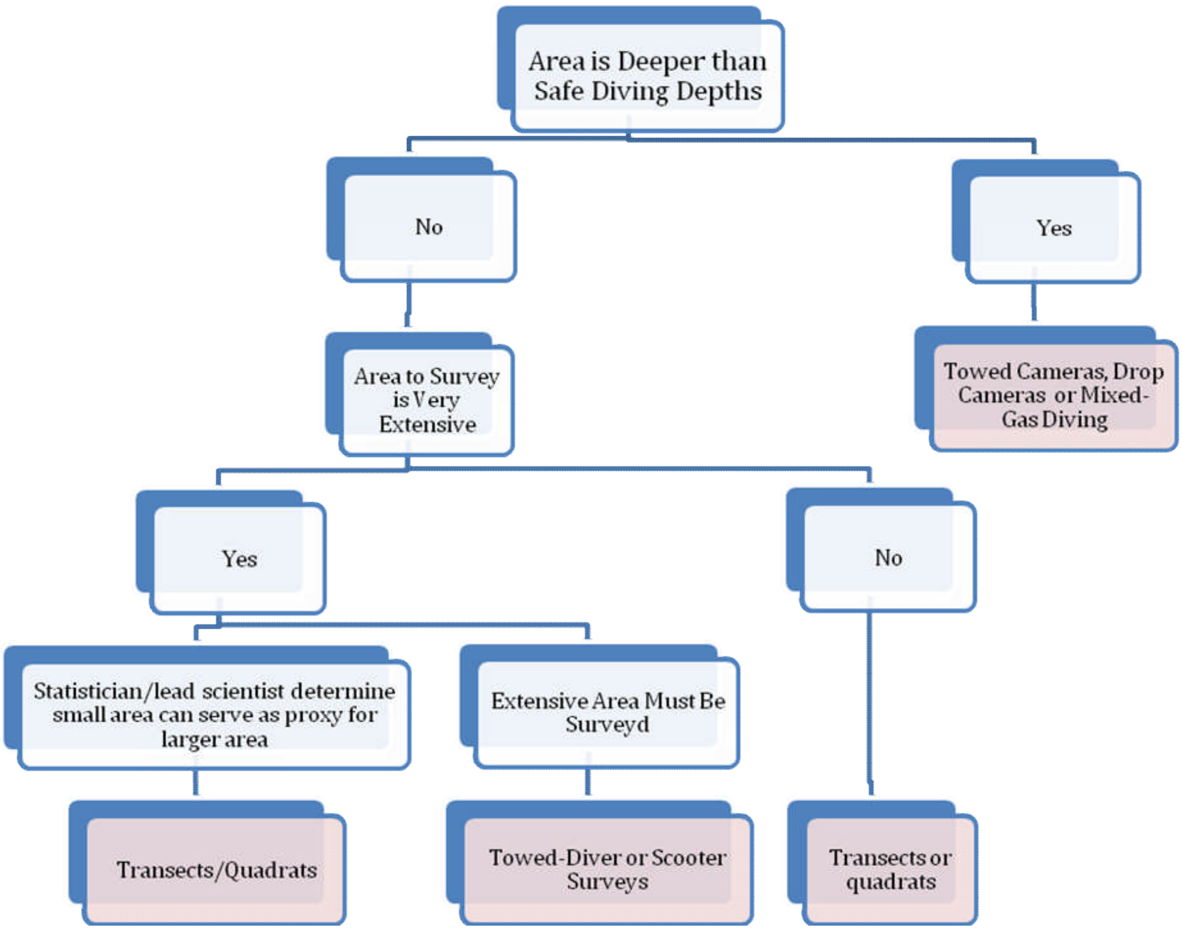

Figure 16. Guide for determining sampling approaches for queen conch fisheries independent sampling.

The decision about the overall area to be surveyed is part of the survey methodology. This determination should be made by the statistician in association with the chief scientist, considering the survey objectives. For example, if the goal of the program is simply to determine ecological associations rather than fisheries quotas, small, directed surveys can achieve the goals. Surveys that are focused on these small ecological questions are not addressed directly in this section; however, the approaches and team structures remain similar.

This notwithstanding, a majority of surveys are focused on determining overall density and/or abundance of a population. The chief scientist (perhaps in association with an independent statistical advisor) determines if a small area can be surveyed that will be a suitable proxy for the larger area. Usually, it is recommended that many small transects are preferred over fewer larger transcts becaue the increase in reprlciations will reduce the variance. In general, these methods are more intensive yet smaller in spatial scope such as using transects or quadrats.

On the other hand, if the statistician determines that more extensive areas need to be surveyed, methods that cover larger areas may be required. These methods cover larger distances and/or areas. Most surveys that have addressed this issue have used towed divers, divers using scooters, or towed cameras. The reader is directed to the review of fisheries independent sampling methods associated with this manual, and to look in Chapter III of this manual for more specific details on the surveys.

The survey sample size will determine the uncertainty related to the estimation of the population. The total abundance $\hat{\tau}$ of the population can be determined using the equation (Mendenhall et al., 1971):

$$\hat{\tau} = N\bar{y} = \frac{N \sum_{i=1}^{n} y_i}{n},$$

Where

$\hat{\tau}$ = Estimated population abundance

N = total number of transect

$\bar{y}$ = mean density per transect

The estimated variance on $\hat{\tau}$ is then based on both the variance within the estimate of $\hat{\tau}$ *as well as* the amount of area sampled relative to the entire area under consideration. This is calculated as:

$$\hat{V}(\hat{\tau}) = N^2 \frac{s^2}{n} \left(\frac{N-n}{N} \right),$$

Where

$$s^2 = \frac{\sum_{i=1}^{n} (y_1 - \bar{y})}{n-1}$$

and,

$\hat{V}(\hat{\tau})$ = Estimated variance on the total population

N = Total area available

n = Area sampled

s^2 = variance of sample

If preliminary surveys have already been conducted, the data may be used to develop a power analysis. Using this tool, an evaluation of the number of surveys that will need to be completed with an acceptable amount of error can be determined. The relationship between the number of surveys and error can be visualized in Figure 17. In general, the relationship indicates that a large number of surveys need to be completed in order to reduce the standard error to very low levels. In those cases, the survey design team may determine accept a higher standard error (more uncertainty) given logistical considerations. For more information on conducting these analyses, please see Zar (1999).

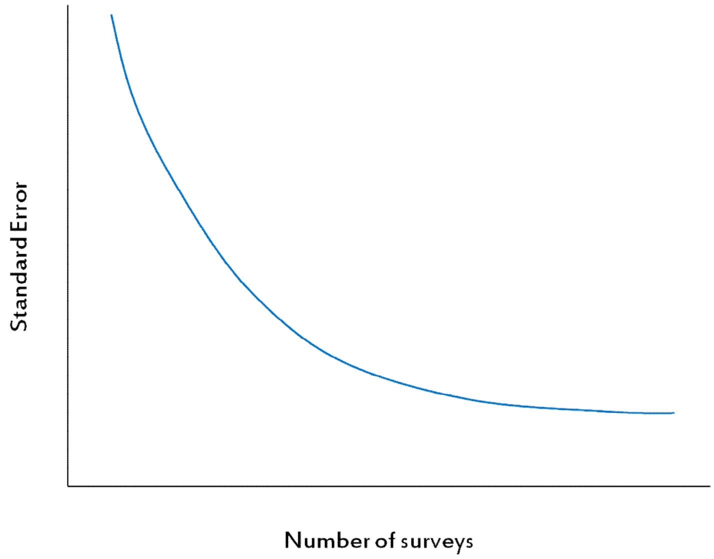

Figure 17. The theoretical relationship between standard error of the mean and total number of samples that need to be conducted.

A second consideration when planning a survey is the selection of the working platform. Several criteria should be considered here:

- A boat sufficiently sized to conveniently and safely deploy divers , fit the entire working team including crew and the dive safety personnel, along with the necessary dive and other scientific equipment and tools,
- The boat has all required documentation, and minimum equipment for safe navigation and communications,
- If necessary. the boat has sufficient capacity to carry additional small vessels in the event they are needed for the surveys.

The third aspect in the survey planning phase is the development of a detailed survey plan. This is a document that compiles the various aspects of the survey containing information about:

- List of the participants along with their emergency contact information, affiliation, and certifications,
- The description of the working platform including its technical characteristics,
- A copy of the valid boat certifications and documentation,

- A statement of the survey objectives and a description of the sampling methods, listing the scientific equipment to be used,
- A detailed timetable,
- Location of the anticipated sampling sites (GPS coordinates and complementarily maps),

In addition to the survey plan, another relevant document is the dive safety plan. As mention before, this dive safety plan summarizes protocols to follow during diving activities, precautions taken to increase safety at sea, and protocols to follow in case of dive emergencies. Some countries require the processing of scientific permits, therefore the availability of a survey plan and a dive safety plan are always good advice to have ready.

The last aspect of the survey preparation refers to the communication protocols, particularly related to those that will be generated from the daily field activities. There is need to clearly define what kind of information, and when and where those communications will be delivered. The communications protocols will be agreed upon among the survey participants, and will depend on the availability of communication capabilities. In remote areas where access to VHF radios is difficult, long-distance radio, renting or buying a satellite telephone is advised.

4.4. Survey development

During the survey development, the core team will define activities to be conducted on a daily basis and assure this plan is known and understood for the rest of the field personnel. Daily plans would be based on the updated wind, wave height, currents, tides forecast and other marine weather reports available for the working area. A number of sources are available to consult for immediate recognitions of conditions including the following websites:

http://www.windfinder.com/
http://www.nhc.noaa.gov/
http://marquitosweather.com/
http://www.intellicast.com/
http://www.intellicast.com/

Because the field work is dynamic and need to respond quickly to environmental conditions, or any other eventuality, coordinators are force to plan in advance for those changes. Access to nautical charts and precise GPS units are both important to respond to rapid changes in daily plans.

Observers should digitize their data, which include the queen information, along with the GPS tracks and waypoints, and pictures. The chief scientist compiles the data and proceeds with the data back-up protocol.

The dive coordinator is responsible for the daily verification of the diving gears proper functioning, making the adjustments when necessary.

The boat captain is responsible for the safe and efficient functioning of the working platform, the provisioning of fuel, and to emergency equipment for both vessel repair and first aid.

The logistic coordinator makes sure that food, and drinking beverages are on board, in enough quantity and responding to special participants demands.

The communication coordinator circulates daily information notes, and responds for other communication strategies.

As mentioned in the introduction, these protocols are mean for broad guidance and particular situations may require different responsibilities and personnel structures.

4.5. Final products from the surveys

Upon completion of the survey and data analysis, the lead scientist is responsible for writing the survey report. The report is expected to contain the following sections: a) introduction; b) description of the survey area; c) a summary of the methodology including field work protocols as well as data analysis approaches; d) results presenting expected conch densities, population abundance, spatial distribution of adult and juvenile conch, including the statistical and GIS products, and the determination of the TAC if population densities meet the predefined minimum threshold; e) data analysis relative to fishing criteria and comparisons with previous studies/different areas; and f) conclusions and recommendations.

A well-written report should be clear, well-organized, have simple figures and maps and be accessible to non-scientists (e.g., politicians, managers, other stakeholders). An executive summary is often valuable as an overview of the project including brief bullets related to all the sections of the report. Depending on the needs of the management authority, this section may include recommendations.

CHAPTER V. PRACTICAL RECOMMENDATIONS

Objective:

By following the recommendations in this chapter, trainees will understand how to maximize the survey effectiveness, increase safety at sea , and integrate quality control procedures.

5.1. Working Platform

- When possible, use a working vessel with efficient and reliable engines thereby reducing fuel consumption and surveys costs,
- Ensure the vessel has been maintained regularly thus reducing risk of having problems at sea.
- Vessels should have a depth sounder, and GPS to support the scientific work.
- The captain should be well-versed in the use of GPS for navigation, marine radio..
- Keep on board a printed copy of the nautical chart with identification of survey stations .
- If applicable, upload to the GPS unit the entire set of field stations, thus they will available when field plans need to be adjusted.
- Choose captains and crews that are familiar with diving activities.

5.2. Scientific work

- Conduct training both onshore and in the field using the methods that will be utilized during the surveys. This will reduce variability associated with data collection. The training should include how to identify conch in the field (including those that are buried), measure conch, methods to deploy the transects, and other activities that may be part of the specific survey. .
- Prepare a detailed checklist of items needed for day-to-day operations. An example of this kind of check list is presented in Annex 2.
- Keep back-up scientific instruments and equipment, in case of malfunction or if a piece of equipment is lost. That include for instance: pencils, plastic boards, rubber bands, GPS, batteries, calipers meters, metric tapes, additional weights, radios, etc.
- The use of special underwater paper is highly recommended although some survey groups prefer underwater slates.
- Ensure that the team is suitably trained in first aid with an emphasis on diving accidents or other common accident which may occur in marine environments (e.g., venomous stings, allergic reactions). Oxygen administration and CPR training is highly recommended.

- File a daily float plan so that someone on shore is knowledgeable about the location of the surveys occurring that day and what time the team is expected to return to the dock. In some cases, notification should be sent to the relevant port or coastal enforcement authority, This may be especially appropriate during surveys that may enter fisheries excluded zones or in cases where the activities can be interpreted as illegal by individuals not familiar with the surveys.
- Mark all scientific tool/equipment especially if you are belonging to different agencies/persons.
- Train observers in general underwater concepts and try to have at least one underwater camera during each dive.
- Download and digitize field data on a daily basis, and establish a protocol to create a data back-up system.

5.3. Diving Activities

- Prior starting the survey program. perform a dive check-out to verify that the dive gear is safe and works properly and that the diver to who the equipment is assigned is comfortable with its use. This is especially critical if the gear is not the diver's own.
- Mark all dive equipment and assign responsibilities for its proper use and care.
- Utilize two buoys, one to mark the station and another for divers to carry when expose, strong currents or low visibility conditions prevail.
- Keep on board additional dive materials and equipment. For example, a 'save-the-dive' kit should include extra max and fin straps, o-rings, silicon lubricant, regulator wrenches) .
- It is strongly recommended that all divers have a review of their condition by a physician along with a certification of fitness to dive. The physician should carefully review any past medical issues and be familiar with bariatric medicine. This recommendations is, of course, difficult to achieve in many small island states, but should be achieved if possible.
- Have a dive master onboard to oversee and help in the diving activities in case of need when relevant. Large operations require greater capacity; small surveys with only 2 or 3 individuals onboard will likely not have the luxury of a divemaster different from the team.
- Obtain detailed contact information for each diver in case of any emergency.
- Make sure that all divers know how to use the Oxygen kit available on board.

We hope that information presented in this manual is

Useful in looking for ways to improve your queen conchs populations.

Good Luck!!!!

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ANNEX 1. Checklists for Queen Conch Fisheries Independent Surveys

Pre-survey Checklist

1. Survey Equipment

   - ☐ GPS
   - ☐ Tape measures (50m - or 100m) if conducting surveys using transects or quadrats
   - ☐ Weights to attach to the tape measures
   - ☐ Underwater Paper or Slates
   - ☐ Underwater Pencil with replacements

   Calipers

   - ☐ Large (overall length)
   - ☐ Small (lip thickness)

2. Dive equipment

   - ☐ Mask, fins, snorkel
   - ☐ Buoyancy compensator
   - ☐ Weight belt
   - ☐ Dive computer (preferably) or depth gauge

3. Safety Equipment
   - ☐ Whistle, dive sausage
   - ☐ Oxygen canister with mask

4. Analyses
   - ☐ Computer with standard spreadsheet programs
   - ☐ Software to and cable to download data from t GPS (e.g., DNR GIS)
   - ☐ Cable for downloading GPS data
   - ☐ GIS software

ANNEX 2. Diving Manual for the American Academy of Underwater Sciences

The American Academy of Underwater Sciences
STANDARDS FOR SCIENTIFIC DIVING

AAUS • 430 Nahant Road, Nahant MA 01908-1696

FOREWORD

Since 1951 the scientific diving community has endeavored to promote safe, effective diving through self-imposed diver training and education programs. Over the years, manuals for diving safety have been circulated between organizations, revised and modified for local implementation, and have resulted in an enviable safety record.

This document represents the minimal safety standards for scientific diving at the present day. As diving science progresses so shall this standard, and it is the responsibility of every member of the Academy to see that it always reflects state of the art, safe diving practice.

American Academy of Underwater Sciences

ACKNOWLEDGEMENTS

The Academy thanks the numerous dedicated individual and organizational members for their contributions and editorial comments in the production of these standards.

Revision History

April, 1987	
October, 1990	
May, 1994	
January, 1996	
March 1999	Added Sec 7.6.1 Nitrox Diving Guidelines.
	Revised Appendix 7 and 11.
January 2001	Revised Section 1.23.1 DSO Qualifications.
	Revised Section 5.31.4 Emergency Care Training.
	Revised Section 6 Medical Standards.
	Made Sec 7.6.1 Nitrox Diving Guidelines into Section 7.
	Added Section 8.0 Scientific Aquarium Diving.
	Moved Section 7.0 to Section 9.0 Other Diving Technologies.
April 2002	Removed Appendix 7 AAUS Checkout Dive and Training Evaluation.
	Revised Section 5.33.3.
	Revised Section 4.23.2.
August 2003	Section 1.27.3 Delete reference to Appendix 9 (checkout dive).
	Section 1.4 Remove word "waiver".
	Section 2.21 Change "supervisor" to "lead diver".
	Section 2.72.2.1 Remove reference to Appendix 13, and remove Appendix 13. Replace with "at www.aaus.org" after Incident Report.
	Section 3.28.3 Remove Appendix 10 (dive computers).
	Section 5.32 Training and 100-hour requirement, eliminate "beyond the DIT level".
	Section 5.32.1 Eliminate paragraph "Suggested topics include" and replace it with a list of topics for inclusion in the 100 hours. Some of these topics would be designated "R" (required).
	Section 4.0 Remove lead sentence "This section describes for diving". Alter the lead sentence read as follows: "This section describes training for the non-diver applicant, previously not certified for diving, and equivalency for the certified diver."
	Section 4.3 Delete this section.
	Section 9 Update Required Decompression (9.10) and Mixed Gas Diving (9.60) to individual sections.
	Appendices 9, 10, 11,and 12 Remove these and make available online as historic documents in the Virtual Office.
	Formatted document for consistency.
	Separated manual into two volumes. Volume 1 and the appendices are required for all manual and Volume 2 sections only apply when the referenced diving activity is being conducted. Volume 2 is where organizational specific information is contained.
October 2005	Section 11.70 Deleted section for rebreathers.
	Section 12.00 Added new section for rebreathers.
March 2006	Section 13.00 Added new section for cave and cavern diving.
	Section 11.5 and 11.6, revised definitions for Hookah and surfaced supplied diving.

April 2006	Section 5.30 Deleted emergency care training prerequisite. Section 5.50 Added emergency care training requirements to Continuation of Certificate.
November 2006	Section 2.60 flying after diving rules updated to meet current DAN standards. Section 3.20 dive computers reference changed to “appendix 8”. Section 3.60 air quality guidelines updated to meet current CGA standards. Section 5.30 – added words “Transect Sampling “to item #9. Appendix 1 – Updated one medical web link. Appendix 2 - Added the abbreviation “DO” to the MD signature line. Appendix 6 – new LOR template. Updated and added Appendix 8 dive computer recommendations Added Appendix 9 (criteria for entering diving statistics).
December 2009	Appendix 2 – Revised
December 2011	Section 6 – Revised and updated after medical review panel suggestions Appendix 1 – Revised Appendix 2 – Revised Appendix 3 – Revised Appendix 4 - Revised

CONTENTS

Volume 1

Sections 1.00 through 6.00
Required For All Organizational Members

SECTION 1.00 GENERAL POLICY

1.10 Scientific Diving Standards

Purpose

The purpose of these Scientific Diving Standards is to ensure that all scientific diving is conducted in a manner that will maximize protection of scientific divers from accidental injury and/or illness, and to set forth standards for training and certification that will allow a working reciprocity between organizational members. Fulfillment of the purposes shall be consistent with the furtherance of research and safety.

This standard sets minimal standards for the establishment of the American Academy of Underwater Sciences (AAUS) recognized scientific diving programs, the organization for the conduct of these programs, and the basic regulations and procedures for safety in scientific diving operations. It also establishes a framework for reciprocity between AAUS organizational members that adhere to these minimum standards.

This standard was developed and written by AAUS by compiling the policies set forth in the diving manuals of several university, private, and governmental scientific diving programs. These programs share a common heritage with the scientific diving program at the Scripps Institution of Oceanography (SIO). Adherence to the SIO standards has proven both feasible and effective in protecting the health and safety of scientific divers since 1954.

In 1982, OSHA exempted scientific diving from commercial diving regulations (29CFR1910, Subpart T) under certain conditions that are outlined below. The final guidelines for the exemption became effective in 1985 (Federal Register, Vol. 50, No.6, p.1046). AAUS is recognized by OSHA as the scientific diving standard setting organization.

Additional standards that extend this document may be adopted by each organizational member, according to local procedure.

Scientific Diving Definition

Scientific diving is defined (29CFR1910.402) as diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks.

Scientific Diving Exemption

OSHA has granted an exemption for scientific diving from commercial diving regulations under the following guidelines (Appendix B to 29CFR1910 Subpart T):

a) The Diving Control Board consists of a majority of active scientific divers and has autonomous and absolute authority over the scientific diving program’s operation.

b) The purpose of the project using scientific diving is the advancement of science; therefore, information and data resulting from the project are non-proprietary.

c) The tasks of a scientific diver are those of an observer and data gatherer. Construction and trouble-shooting tasks traditionally associated with commercial diving are not included within scientific diving.

d) Scientific divers, based on the nature of their activities, must use scientific expertise in studying the underwater environment and therefore, are scientists or scientists-in-training.

e) In addition, the scientific diving program shall contain at least the following elements (29CFR1910.401):

1. Diving safety manual which includes at a minimum: Procedures covering all diving operations specific to the program; including procedures for emergency care, recompression and evacuation, and the criteria for diver training and certification.

2. Diving control (safety) board, with the majority of its members being active scientific divers, which shall at a minimum have the authority to: approve and monitor diving projects, review and revise the diving safety manual, assure compliance with the manual, certify the depths to which a diver has been trained, take disciplinary action for unsafe practices, and assure adherence to the buddy system (a diver is accompanied by and is in continuous contact with another diver in the water) for scuba diving.

Review of Standards

As part of each organizational member's annual report, any recommendations for modifications of these standards shall be submitted to the AAUS for consideration.

1.20 Operational Control

Organizational Member Auspices Defined

For the purposes of these standards the auspices of the organizational member includes any scientific diving operation in which an organizational member is connected because of ownership of any equipment used, locations selected, or relationship with the individual(s) concerned. This includes all cases involving the operations of employees of the organizational member or employees of auxiliary organizations, where such employees are acting within the scope of their employment, and the operations of other persons who are engaged in scientific diving of the organizational member or are diving as members of an organization recognized by the AAUS organizational member.

It is the organizational member's responsibility to adhere to the AAUS Standards for Scientific Diving Certification and Operation of Scientific Diving Programs. The administration of the local diving program will reside with the organizational member's Diving Control Board (DCB).

The regulations herein shall be observed at all locations where scientific diving is conducted.

Organizational Member's Scientific Diving Standards and Safety Manual

Each organizational member shall develop and maintain a scientific diving safety manual that provides for the development and implementation of policies and procedures that will enable each organizational member to meet requirements of local environments and conditions as well as to comply with the AAUS scientific diving standards. The organizational member's scientific diving manual shall include, but not be limited to:

a) AAUS standards may be used as a set of minimal guidelines for the development of an organizational member's scientific diving safety manual. Volume 1, Sections 1.00 through 6.00 and the Appendices are required for all manuals. Volume 2, Sections 7.00 through 9.00 are required only when the organizational member conducts that diving activity. Organizational member specific sections are placed in Volume 2.

b) Emergency evacuation and medical treatment procedures.

c) Criteria for diver training and certification.

d) Standards written or adopted by reference for each diving mode utilized which include the following:

   1. Safety procedures for the diving operation.
   2. Responsibilities of the dive team members.
   3. Equipment use and maintenance procedures.
   4. Emergency procedures.

Diving Safety Officer

The Diving Safety Officer (DSO) serves as a member of the Diving Control Board (DCB). This person should have broad technical and scientific expertise in research related diving.

a) Qualifications

   1. Shall be appointed by the responsible administrative officer or designee, with the advice and counsel of the Diving Control Board.
   2. Shall be trained as a scientific diver.
   3. Shall be a full member as defined by AAUS.
   4. Shall be an active underwater instructor from an internationally recognized certifying agency.

b) Duties and Responsibilities

   1. Shall be responsible, through the DCB, to the responsible administrative officer or designee, for the conduct of the scientific diving program of the membership organization. The routine operational authority for this program, including the conduct of training and certification, approval of dive plans, maintenance of diving records, and ensuring compliance with this standard and all relevant regulations of the membership organization, rests with the Diving Safety Officer.
   2. May permit portions of this program to be carried out by a qualified delegate, although the Diving Safety Officer may not delegate responsibility for the safe conduct of the local diving program.
   3. Shall be guided in the performance of the required duties by the advice of the DCB, but operational responsibility for the conduct of the local diving program will be retained by the Diving Safety Officer.
   4. Shall suspend diving operations considered to be unsafe or unwise.

Diving Control Board

a) The Diving Control Board (DCB) shall consist of a majority of active scientific divers. Voting members shall include the Diving Safety Officer, the responsible administrative officer, or designee, and should include other representatives of the diving program such as qualified divers and members selected by procedures established by each organizational member. A chairperson and a secretary may be chosen from the membership of the board according to local procedure.

b) Has autonomous and absolute authority over the scientific diving program's operation.

c) Shall approve and monitor diving projects.

d) Shall review and revise the diving safety manual.

e) Shall assure compliance with the diving safety manual.

f) Shall certify the depths to which a diver has been trained.

g) Shall take disciplinary action for unsafe practices.

h) Shall assure adherence to the buddy system for scuba diving.

i) Shall act as the official representative of the membership organization in matters concerning the scientific diving program.

j) Shall act as a board of appeal to consider diver-related problems.

k) Shall recommend the issue, reissue, or the revocation of diving certifications.

l) Shall recommend changes in policy and amendments to AAUS and the membership organization's diving safety manual as the need arises.

m) Shall establish and/or approve training programs through which the applicants for certification can satisfy the requirements of the organizational member's diving safety manual.

n) Shall suspend diving programs that are considered to be unsafe or unwise.

o) Shall establish criteria for equipment selection and use.

p) Shall recommend new equipment or techniques.

q) Shall establish and/or approve facilities for the inspection and maintenance of diving and associated equipment.

r) Shall ensure that the organizational member's air station(s) meet air quality standards as described in Section 3.60.

s) Shall periodically review the Diving Safety Officer's performance and program.

t) Shall sit as a board of investigation to inquire into the nature and cause of diving accidents or violations of the organizational member's diving safety manual.

Instructional Personnel

a) Qualifications - All personnel involved in diving instruction under the auspices of the organizational member shall be qualified for the type of instruction being given.

b) Selection - Instructional personnel will be selected by the responsible administrative officer, or designee, who will solicit the advice of the DCB in conducting preliminary screening of applicants for instructional positions.

Lead Diver

For each dive, one individual shall be designated as the Lead Diver who shall be at the dive location during the diving operation. The Lead Diver shall be responsible for:

a) Coordination with other known activities in the vicinity that are likely to interfere with diving operations.

b) Ensuring all dive team members possess current certification and are qualified for the type of diving operation.

c) Planning dives in accordance with Section 2.20

d) Ensuring safety and emergency equipment is in working order and at the dive site.

e) Briefing dive team members on:

    1. Dive objectives.

    2. Unusual hazards or environmental conditions likely to affect the safety of the diving operation.

    3. Modifications to diving or emergency procedures necessitated by the specific diving operation.

    4. Suspending diving operations if in their opinion conditions are not safe.

    5. Reporting to the DSO and DCB any physical problems or adverse physiological effects including symptoms of pressure-related injuries.

Reciprocity and Visiting Scientific Diver

a) Two or more AAUS Organizational Members engaged jointly in diving activities, or engaged jointly in the use of diving resources, shall designate one of the participating Diving Control Boards to govern the joint dive project.

b) A Scientific Diver from one Organizational Member shall apply for permission to dive under the auspices of another Organizational Member by submitting to the Diving Safety Officer of the host Organizational Member a document containing all the information described in Appendix 6, signed by the Diving Safety Officer or Chairperson of the home Diving Control Board.

c) A visiting Scientific Diver may be asked to demonstrate their knowledge and skills for the planned dive.

d) If a host Organizational Member denies a visiting Scientific Diver permission to dive, the host Diving Control Board shall notify the visiting Scientific Diver and their Diving Control Board with an explanation of all reasons for the denial.

Waiver of Requirements

The organizational Diving Control Board may grant a waiver for specific requirements of training, examinations, depth certification, and minimum activity to maintain certification.

1.30 Consequence of Violation of Regulations by Scientific Divers

Failure to comply with the regulations of the organizational member's diving safety manual may be cause for the revocation or restriction of the diver's scientific diving certificate by action of the organizational member's Diving Control Board.

1.40 Consequences of Violation of Regulations by Organizational Members

Failure to comply with the regulations of this standard may be cause for the revocation or restriction of the organizational member's recognition by AAUS.

1.50 Record Maintenance

The Diving Safety Officer or designee shall maintain permanent records for each Scientific Diver certified. The file shall include evidence of certification level, log sheets, results of current physical examination, reports of disciplinary actions by the organizational member Diving Control Board, and other pertinent information deemed necessary.

Availability of Records:

a) Medical records shall be available to the attending physician of a diver or former diver when released in writing by the diver.

b) Records and documents required by this standard shall be retained by the organizational member for the following period:

    1. Physician's written reports of medical examinations for dive team members - 5 years.
    2. Diving safety manual - current document only.
    3. Records of dive - 1 year, except 5 years where there has been an incident of pressure-related injury.
    4. Pressure-related injury assessment - 5 years.
    5. Equipment inspection and testing records - current entry or tag, or until equipment is withdrawn from service.

SECTION 2.00 DIVING REGULATIONS FOR SCUBA (OPEN CIRCUIT, COMPRESSED AIR)

2.10 Introduction

No person shall engage in scientific diving operations under the auspices of the member's organizational scientific diving program unless they hold a current certification issued pursuant to the provisions of this standard.

2.20 Pre-Dive Procedures

Dive Plans

Dives should be planned around the competency of the least experienced diver. Before conducting any diving operations under the auspices of the organizational member, the lead diver for a proposed operation must formulate a dive plan that should include the following:

a) Divers qualifications, and the type of certificate or certification held by each diver.

b) Emergency plan (Appendix 7) with the following information:

  1. Name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency.
  2. Nearest operational decompression chamber.
  3. Nearest accessible hospital.
  4. Available means of transport.

c) Approximate number of proposed dives.

d) Location(s) of proposed dives.

e) Estimated depth(s) and bottom time(s) anticipated.

f) Decompression status and repetitive dive plans, if required.

g) Proposed work, equipment, and boats to be employed.

h) Any hazardous conditions anticipated.

Pre-dive Safety Checks

a) Diver's Responsibility:

  1. Scientific divers shall conduct a functional check of their diving equipment in the presence of the diving buddy or tender.
  2. It is the diver's responsibility and duty to refuse to dive if, in their judgment, conditions are unfavorable, or if they would be violating the precepts of their training, of this standard, or the organizational member's diving safety manual.
  3. No dive team member shall be required to be exposed to hyperbaric conditions against their will, except when necessary to prevent or treat a pressure-related injury.
  4. No dive team member shall be permitted to dive for the duration of any known condition, which is likely to adversely affect the safety and health of the diver or other dive members.

b) Equipment Evaluations

1. Divers shall ensure that their equipment is in proper working order and that the equipment is suitable for the type of diving operation.
2. Each diver shall have the capability of achieving and maintaining positive buoyancy.

c) Site Evaluation - Environmental conditions at the site will be evaluated.

2.30 Diving Procedures

Solo Diving Prohibition

All diving activities shall assure adherence to the buddy system for scuba diving. This buddy system is based upon mutual assistance, especially in the case of an emergency.

Refusal to Dive

a) The decision to dive is that of the diver. A diver may refuse to dive, without fear of penalty, whenever they feel it is unsafe for them to make the dive.

b) Safety - The ultimate responsibility for safety rests with the individual diver. It is the diver's responsibility and duty to refuse to dive if, in their judgment, conditions are unsafe or unfavorable, or if they would be violating the precepts of their training or the regulations in this standard.

Termination of the Dive

a) It is the responsibility of the diver to terminate the dive, without fear of penalty, whenever they feel it is unsafe to continue the dive, unless it compromises the safety of another diver already in the water.

b) The dive shall be terminated while there is still sufficient cylinder pressure to permit the diver to safely reach the surface, including decompression time, or to safely reach an additional air source at the decompression station.

Emergencies and Deviations from Regulations

Any diver may deviate from the requirements of this standard to the extent necessary to prevent or minimize a situation that is likely to cause death, serious physical harm, or major environmental damage. A written report of such actions must be submitted to the Diving Control Board explaining the circumstances and justifications.

2.40 Post-Dive Procedures

Post-Dive Safety Checks

a) After the completion of a dive, each diver shall report any physical problems, symptoms of decompression sickness, or equipment malfunctions.

b) When diving outside the no-decompression limits, the divers should remain awake for at least 1 hour after diving, and in the company of a dive team member who is prepared to transport them to a decompression chamber if necessary.

2.50 Emergency Procedures

Each organizational member will develop emergency procedures which follow the standards of care of the community and must include procedures for emergency care, recompression and evacuation for each dive location (Appendix 7).

2.60 Flying After Diving or Ascending to Altitude (Over 1000 feet)

Following a Single No-Decompression Dive: Divers should have a minimum preflight surface interval of 12 hours.

Following Multiple Dives per Day or Multiple Days of Diving: Divers should have a minimum preflight surface interval of 18 hours.

Following Dives Requiring Decompression Stops: Divers should have a minimum preflight surface interval of 24 hours.

Before ascending to Altitude above (1000 feet) by Land Transport: Divers should follow the appropriate guideline for preflight surface intervals unless the decompression procedure used has accounted for the increase in elevation.

2.70 Record Keeping Requirements

Personal Diving Log

Each certified scientific diver shall log every dive made under the auspices of the organizational member's program, and is encouraged to log all other dives. Standard forms will be provided by each membership organization. Log sheets shall be submitted to the Diving Safety Officer to be placed in the diver's permanent file. Details of the submission procedures are left to the discretion of the Diving Safety Officer. The diving log shall be in a form specified by the organization and shall include at least the following:

a) Name of diver, buddy, and Lead Diver.

b) Date, time, and location.

c) Diving modes used.

d) General nature of diving activities.

e) Approximate surface and underwater conditions.

f) Maximum depths, bottom time, and surface interval time.

g) Diving tables or computers used.

h) Detailed report of any near or actual incidents.

Required Incident Reporting

All diving incidents requiring recompression treatment, or resulting in moderate or serious injury, or death shall be reported to the Organizational Member's Diving Control Board and the AAUS. The organizational member's regular procedures for incident reporting, including those required by the AAUS, shall be followed. The report will specify the circumstances of the incident and the extent of any injuries or illnesses.

Additional information must meet the following reporting requirements:

a) Organizational member shall record and report occupational injuries and illnesses in accordance with requirements of the appropriate Labor Code section.

b) If pressure-related injuries are suspected, or if symptoms are evident, the following additional information shall be recorded and retained by the organizational member, with the record of the dive, for a period of 5 years:

1. Complete AAUS Incident Report at http://www.aaus.org.
2. Written descriptive report to include:
   - Name, address, phone numbers of the principal parties involved.
   - Summary of experience of divers involved.
   - Location, description of dive site, and description of conditions that led up to incident.
   - Description of symptoms, including depth and time of onset.
   - Description and results of treatment.
   - Disposition of case.
   - Recommendations to avoid repetition of incident.

c) Organizational member shall investigate and document any incident of pressure-related injury and prepare a report that is to be forwarded to AAUS during the annual reporting cycle. This report must first be reviewed and released by the organizational member's Diving Control Board.

SECTION 3.00 DIVING EQUIPMENT

3.10 General Policy

All equipment shall meet standards as determined by the Diving Safety Officer and the Diving Control Board. Equipment that is subjected to extreme usage under adverse conditions should require more frequent testing and maintenance.

All equipment shall be regularly examined by the person using them.

3.20 Equipment

Regulators

a) Only those makes and models specifically approved by the Diving Safety Officer and the Diving Control Board shall be used.

b) Scuba regulators shall be inspected and tested prior to first use and every 12 months thereafter.

c) Regulators will consist of a primary second stage and an alternate air source (such as an octopus second stage or redundant air supply).

Breathing Masks and Helmets

Breathing masks and helmets shall have:

a) A non-return valve at the attachment point between helmet or mask and hose, which shall close readily and positively.

b) An exhaust valve.

c) A minimum ventilation rate capable of maintaining the diver at the depth to which they are diving.

Scuba Cylinders

a) Scuba cylinders shall be designed, constructed, and maintained in accordance with the applicable provisions of the Unfired Pressure Vessel Safety Orders.

b) Scuba cylinders must be hydrostatically tested in accordance with DOT standards.

c) Scuba cylinders must have an internal and external inspection at intervals not to exceed 12 months.

d) Scuba cylinder valves shall be functionally tested at intervals not to exceed 12 months.

Backpacks

Backpacks without integrated flotation devices and weight systems shall have a quick release device designed to permit jettisoning with a single motion from either hand.

Gauges

Gauges shall be inspected and tested before first use and every 12 months thereafter.

Flotation Devices

a) Each diver shall have the capability of achieving and maintaining positive buoyancy.

b) Personal flotation systems, buoyancy compensators, dry suits, or other variable volume buoyancy compensation devices shall be equipped with an exhaust valve.

c) These devices shall be functionally inspected and tested at intervals not to exceed 12 months.

Timing Devices, Depth, and Pressure Gauges

Both members of the buddy team must have an underwater timing device, an approved depth indicator, and a submersible pressure gauge.

Determination of Decompression Status: Dive Tables, Dive Computers

a) A set of diving tables, approved by the Diving Control Board, must be available at the dive location.

b) Dive computers may be utilized in place of diving tables, and must be approved by the Diving Control Board. AAUS recommendations on dive computers are located in appendix 8

3.30 Auxiliary Equipment

Hand held underwater power tools. Electrical tools and equipment used underwater shall be specifically approved for this purpose. Electrical tools and equipment supplied with power from the surface shall be de-energized before being placed into or retrieved from the water. Hand held power tools shall not be supplied with power from the dive location until requested by the diver.

3.40 Support Equipment

First aid supplies

A first aid kit and emergency oxygen shall be available.

Diver's Flag

A diver's flag shall be displayed prominently whenever diving is conducted under circumstances where required or where water traffic is probable.

Compressor Systems - Organizational Member Controlled

The following will be considered in design and location of compressor systems:

a) Low-pressure compressors used to supply air to the diver if equipped with a volume tank shall have a check valve on the inlet side, a relief valve, and a drain valve.

b) Compressed air systems over 500 psig shall have slow-opening shut-off valves.

c) All air compressor intakes shall be located away from areas containing exhaust or other contaminants.

3.50 Equipment Maintenance

Record Keeping

Each equipment modification, repair, test, calibration, or maintenance service shall be logged, including the date and nature of work performed, serial number of the item, and the name of the person performing the work for the following equipment:

a) Regulators
b) Submersible pressure gauges
c) Depth gauges
d) Scuba cylinders
e) Cylinder valves
f) Diving helmets
g) Submersible breathing masks
h) Compressors
i) Gas control panels
j) Air storage cylinders
k) Air filtration systems
l) Analytical instruments
m) Buoyancy control devices
n) Dry suits

Compressor Operation and Air Test Records

a) Gas analyses and air tests shall be performed on each organizational member-controlled breathing air compressor at regular intervals of no more than 100 hours of operation or 6 months, whichever occurs first. The results of these tests shall be entered in a formal log and be maintained.

b) A log shall be maintained showing operation, repair, overhaul, filter maintenance, and temperature adjustment for each compressor.

3.60 Air Quality Standards

Breathing air for scuba shall meet the following specifications as set forth by the Compressed Gas Association (CGA Pamphlet G-7.1).

CGA Grade E	
Component	**Maximum**
Oxygen	20 - 22%/v
Carbon Monoxide	10 PPM/v
Carbon Dioxide	1000 PPM/v
Condensed Hydrocarbons	5 mg/m3
Total Hydrocarbons as Methane	25 PPM/v
Water Vapor ppm	(2)
Objectionable Odors	None

For breathing air used in conjunction with self-contained breathing apparatus in extreme cold where moisture can condense and freeze, causing the breathing apparatus to malfunction, a dew point not to exceed -50°F (63 pm v/v) or 10 degrees lower than the coldest temperature expected in the area is required.

SECTION 4.00 ENTRY-LEVEL TRAINING REQUIREMENTS

This section describes training for the non-diver applicant, previously not certified for diving, and equivalency for the certified diver.

4.10 Evaluation

Medical Examination

The applicant for training shall be certified by a licensed physician to be medically qualified for diving before proceeding with the training as designated in Section 4.20 (Section 6.00 and Appendices 1 through 4).

Swimming Evaluation

Applicant shall successfully perform the following tests, or equivalent, in the presence of the Diving Safety Officer, or an examiner approved by the Diving Safety Officer.

a) Swim underwater without swim aids for a distance of 25 yards without surfacing.

b) Swim 400 yards in less than 12 minutes without swim aids.

c) Tread water for 10 minutes, or 2 minutes without the use of hands, without swim aids.

d) Without the use of swim aids, transport another person of equal size a distance of 25 yards in the water.

4.20 Scuba Training

Practical Training

At the completion of training, the trainee must satisfy the Diving Safety Officer or the instructor of their ability to perform the following, as a minimum, in a pool or in sheltered water:

a) Enter water with full equipment.

b) Clear face mask.

c) Demonstrate air sharing, including both buddy breathing and the use of alternate air source, as both donor and recipient, with and without a face mask.

d) Demonstrate ability to alternate between snorkel and scuba while kicking.

e) Demonstrate understanding of underwater signs and signals.

f) Demonstrate simulated in-water mouth-to-mouth resuscitation.

g) Rescue and transport, as a diver, a passive simulated victim of an accident.

h) Demonstrate ability to remove and replace equipment while submerged.

i) Demonstrate watermanship ability, which is acceptable to the instructor.

Written Examination

Before completing training, the trainee must pass a written examination that demonstrates knowledge of at least the following:

a) Function, care, use, and maintenance of diving equipment.
b) Physics and physiology of diving.
c) Diving regulations and precautions.
d) Near-shore currents and waves.
e) Dangerous marine animals.
f) Emergency procedures, including buoyant ascent and ascent by air sharing.
g) Currently accepted decompression procedures.
h) Demonstrate the proper use of dive tables.
i) Underwater communications.
j) Aspects of freshwater and altitude diving.
k) Hazards of breath-hold diving and ascents.
l) Planning and supervision of diving operations.
m) Diving hazards.
n) Cause, symptoms, treatment, and prevention of the following: near drowning, air embolism, carbon dioxide excess, squeezes, oxygen poisoning, nitrogen narcosis, exhaustion and panic, respiratory fatigue, motion sickness, decompression sickness, hypothermia, and hypoxia/anoxia.

Open Water Evaluation

The trainee must satisfy an instructor, approved by the Diving Safety Officer, of their ability to perform at least the following in open water:

a) Surface dive to a depth of 10 feet in open water without scuba.
b) Demonstrate proficiency in air sharing as both donor and receiver.
c) Enter and leave open water or surf, or leave and board a diving vessel, while wearing scuba gear.
d) Kick on the surface 400 yards while wearing scuba gear, but not breathing from the scuba unit.
e) Demonstrate judgment adequate for safe diving.
f) Demonstrate, where appropriate, the ability to maneuver efficiently in the environment, at and below the surface.
g) Complete a simulated emergency swimming ascent.
h) Demonstrate clearing of mask and regulator while submerged.
i) Demonstrate ability to achieve and maintain neutral buoyancy while submerged.
j) Demonstrate techniques of self-rescue and buddy rescue.
k) Navigate underwater.
l) Plan and execute a dive.
m) Successfully complete 5 open water dives for a minimum total time of 3 hours, of which 1-1/2 hours cumulative bottom time must be on scuba. No more than 3 training dives shall be made in any 1day.

SECTION 5.00 SCIENTIFIC DIVER CERTIFICATION

5.10 Certification Types

Scientific Diver Certification

This is a permit to dive, usable only while it is current and for the purpose intended.

Temporary Diver Permit

This permit constitutes a waiver of the requirements of Section 5.00 and is issued only following a demonstration of the required proficiency in diving. It is valid only for a limited time, as determined by the Diving Safety Officer. This permit is not to be construed as a mechanism to circumvent existing standards set forth in this standard.

a) Requirements of this section may be waived by the Diving Safety Officer if the person in question has demonstrated proficiency in diving and can contribute measurably to a planned dive. A statement of the temporary diver's qualifications shall be submitted to the Diving Safety Officer as a part of the dive plan. Temporary permits shall be restricted to the planned diving operation and shall comply with all other policies, regulations, and standards of this standard, including medical requirements.

5.20 General Policy

AAUS requires that no person shall engage in scientific diving unless that person is authorized by an organizational member pursuant to the provisions of this standard. Only a person diving under the auspices of the organizational member that subscribes to the practices of AAUS is eligible for a scientific diver certification.

5.30 Requirements For Scientific Diver Certification

Submission of documents and participation in aptitude examinations does not automatically result in certification. The applicant must convince the Diving Safety Officer and members of the DCB that they are sufficiently skilled and proficient to be certified. This skill will be acknowledged by the signature of the Diving Safety Officer. Any applicant who does not possess the necessary judgment, under diving conditions, for the safety of the diver and their partner, may be denied organizational member scientific diving privileges. Minimum documentation and examinations required are as follows:

Prerequisites

a) Application - Application for certification shall be made to the Diving Safety Officer on the form prescribed by the organizational member.

b) Medical approval. Each applicant for diver certification shall submit a statement from a licensed physician, based on an approved medical examination, attesting to the applicant's fitness for diving (Section 6.00 and Appendices 1 through 4).

c) Scientific Diver-In-Training Permit - This permit signifies that a diver has completed and been certified as at least an open water diver through an internationally recognized certifying agency or scientific diving program, and has the knowledge skills and experience equivalent to that gained by successful completion of training as specified in Section 4.00.

Theoretical and Practical Training

The diver must complete theoretical aspects and practical training for a minimum cumulative time of 100 hours. Theoretical aspects shall include principles and activities appropriate to the intended area of scientific study.

a) Required Topics (include, but not limited to):

1. Diving Emergency Care Training
   - Cardiopulmonary Resuscitation (CPR)
   - Standard or Basic First Aid
   - Recognition of DCS and AGE
   - Accident Management
   - Field Neurological Exam
   - Oxygen Administration
2. Dive Rescue
3. Dive Physics
4. Dive Physiology
5. Dive Environments
6. Decompression Theory and its Application
7. AAUS Scientific Diving Regulations and History
   - Scientific Dive Planning
   - Coordination with other Agencies
   - Appropriate Governmental Regulations
8. Scientific Method
9. Data Gathering Techniques (Only Items specific to area of study are required)
   - Transect Sampling (Quadrating)
   - Transecting
   - Mapping
   - Coring
   - Photography
   - Tagging
   - Collecting
   - Animal Handling
   - Archaeology

- Common Biota
    - Organism Identification
    - Behavior
    - Ecology
- Site Selection, Location, and Re-location
- Specialized Equipment for data gathering
- HazMat Training
- HP Cylinders
- Chemical Hygiene, Laboratory Safety (Use Of Chemicals)

b) Suggested Topics (include, but not limited to):

1. Specific Dive Modes (methods of gas delivery)
    - Open Circuit
    - Hooka
    - Surface Supplied diving
2. Small Boat Operation
3. Rebreathers
    - Closed
    - Semi-closed
4. Specialized Breathing Gas
    - Nitrox
    - Mixed Gas
5. Specialized Environments and Conditions
    - Blue Water Diving,
    - Ice and Polar Diving (Cold Water Diving)
    - Zero Visibility Diving
    - Polluted Water Diving,
    - Saturation Diving
    - Decompression Diving
    - Overhead Environments
    - Aquarium Diving
    - Night Diving
    - Kelp Diving
    - Strong Current Diving (Live-boating)
    - Potential Entanglement
6. Specialized Diving Equipment
    - Full face mask
    - Dry Suit
    - Communications

c) Practical training must include a checkout dive, with evaluation of the skills listed in Section 4.20 (Open Water Evaluation), with the DSO or qualified delegate followed by at least 11 ocean or open water dives in a variety of dive sites and diving conditions, for a cumulative bottom time of 6 hours. Dives following the checkout dive must be supervised by a certified Scientific Diver with experience in the type of diving planned, with the knowledge and permission of the DSO.

d) Examinations

1. Written examination

- General exam required for scientific diver certification.
- Examination covering the suggested topics at the DSO's discretion.

2. Examination of equipment.

- Personal diving equipment
- Task specific equipment

5.40 Depth Certifications

Depth Certifications and Progression to Next Depth Level

A certified diver diving under the auspices of the organizational member may progress to the next depth level after successfully completing the required dives for the next level. Under these circumstances the diver may exceed their depth limit. Dives shall be planned and executed under close supervision of a diver certified to this depth, with the knowledge and permission of the DSO.

a) Certification to 30 Foot Depth - Initial permit level, approved upon the successful completion of training listed in Section 4.00 and 5.30.

b) Certification to 60 Foot Depth - A diver holding a 30 foot certificate may be certified to a depth of 60 feet after successfully completing, under supervision, 12 logged training dives to depths between 31 and 60 feet, for a minimum total time of 4 hours.

c) Certification to 100 Foot Depth - A diver holding a 60 foot certificate may be certified to a depth of 100 feet after successfully completing, 4 dives to depths between 61 and 100 feet. The diver shall also demonstrate proficiency in the use of the appropriate Dive Tables.

d) Certification to 130 Foot Depth - A diver holding a 100 foot certificate may be certified to a depth of 130 feet after successfully completing, 4 dives to depths between 100 and 130 feet. The diver shall also demonstrate proficiency in the use of the appropriate Dive Tables.

e) Certification to 150 Foot Depth - A diver holding a 130 foot certificate may be certified to a depth of 150 feet after successfully completing, 4 dives to depths between 130 and 150 feet. The diver must also demonstrate knowledge of the special problems of deep diving, and of special safety requirements.

f) Certification to 190 Foot Depth - A diver holding a 150 foot certificate may be certified to a depth of 190 feet after successfully completing, 4 dives to depths between 150 and 190 feet. The diver must also demonstrate knowledge of the special problems of deep diving, and of special safety requirements.

Diving on air is not permitted beyond a depth of 190 feet.

5.50 Continuation of Certificate

Minimum Activity to Maintain Certification

During any 12-month period, each certified scientific diver must log a minimum of 12 dives. At least one dive must be logged near the maximum depth of the diver's certification during each 6-month period. Divers certified to 150 feet or deeper may satisfy these requirements with dives to 130 feet or over. Failure to meet these requirements may be cause for revocation or restriction of certification.

Re-qualification of Depth Certificate

Once the initial certification requirements of Section 5.30 are met, divers whose depth certification has lapsed due to lack of activity may be re-qualified by procedures adopted by the organization's DCB.

Medical Examination

All certified scientific divers shall pass a medical examination at the intervals specified in Section 6.10. After each major illness or injury, as described in Section 6.10, a certified scientific diver shall receive clearance to return to diving from a physician before resuming diving activities.

Emergency Care Training.

The scientific diver must provide proof of training in the following:

- Adult CPR (must be current).
- Emergency oxygen administration (must be current)
- First aid for diving accidents (must be current)

5.60 Revocation of Certification

A diving certificate may be revoked or restricted for cause by the Diving Safety Officer or the DCB. Violations of regulations set forth in this standard, or other governmental subdivisions not in conflict with this standard, may be considered cause. Diving Safety Officer shall inform the diver in writing of the reason(s) for revocation. The diver will be given the opportunity to present their case in writing for reconsideration and/or re-certification. All such written statements and requests, as identified in this section, are formal documents, which will become part of the diver's file.

5.70 Recertification

If a diver's certificate expires or is revoked, they may be re-certified after complying with such conditions as the Diving Safety Officer or the DCB may impose. The diver shall be given an opportunity to present their case to the DCB before conditions for re-certification are stipulated.

SECTION 6.00 MEDICAL STANDARDS

6.10 Medical Requirements

General

g) The organizational member shall determine that divers have passed a current diving physical examination and have been declared by the examining physician to be fit to engage in diving activities as may be limited or restricted in the medical evaluation report.

h) All medical evaluations required by this standard shall be performed by, or under the direction of, a licensed physician of the applicant-diver's choice, preferably one trained in diving/undersea medicine.

i) The diver should be free of any chronic disabling disease and any conditions contained in the list of conditions for which restrictions from diving are generally recommended. (Appendix 1)

Frequency of Medical Evaluations

Medical evaluation shall be completed:

j) Before a diver may begin diving, unless an equivalent initial medical evaluation has been given within the preceding 5 years (3 years if over the age of 40, 2 years if over the age of 60), the member organization has obtained the results of that examination, and those results have been reviewed and found satisfactory by the member organization.

k) Thereafter, at 5 year intervals up to age 40, every 3 years after the age of 40, and every 2 years after the age of 60.

l) Clearance to return to diving must be obtained from a physician following any major injury or illness, or any condition requiring hospital care or chronic medication. If the injury or illness is pressure related, then the clearance to return to diving must come from a physician trained in diving medicine.

Information Provided Examining Physician

The organizational member shall provide a copy of the medical evaluation requirements of this standard to the examining physician. (Appendices 1, 2, and 3).

Content of Medical Evaluations

Medical examinations conducted initially and at the intervals specified in Section 6.10 shall consist of the following:

m) Applicant agreement for release of medical information to the Diving Safety Officer and the DCB (Appendix 2).

n) Medical history (Appendix 3).

o) Diving physical examination (Required tests listed below and in Appendix 2).

Conditions Which May Disqualify Candidates From Diving (Adapted from Bove, 1998)

p) Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to auto inflate the middle ears.
q) Hearing loss; Vertigo including Meniere's Disease.
r) Stapedectomy or middle ear reconstructive surgery.
s) Recent ocular surgery.
t) Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, depression.
u) Substance abuse, including alcohol.
v) Episodic loss of consciousness.
w) History of seizure.
x) History of stroke or a fixed neurological deficit.
y) Recurring neurologic disorders, including transient ischemic attacks.
z) History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage.
aa) History of neurological decompression illness with residual deficit.
bb) Head injury.
cc) Hematologic disorders including coagulopathies.
dd) Risk factors or evidence of coronary artery disease.
ee) Atrial septal defects.
ff) Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying.
gg) Significant cardiac rhythm or conduction abnormalities.
hh) Implanted cardiac pacemakers and cardiac defibrillators (ICD).
ii) Inadequate exercise tolerance.
jj) Hypertension.
kk) History of pneumothorax.
ll) Asthma.
mm) Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae or cysts.
nn) Diabetes mellitus.
oo) Pregnancy.

Laboratory Requirements for Diving Medical Evaluation and Intervals.

pp) Initial examination under age 40:

* Medical History
* Complete Physical Exam, emphasis on neurological and otological components
* Urinalysis
* Any further tests deemed necessary by the physician.

qq) Periodic re-examination under age 40 (every 5 years):

* Medical History
* Complete Physical Exam, emphasis on neurological and otological components
* Urinalysis
* Any further tests deemed necessary by the physician

rr) First exam over age 40:

* Medical History

* Complete Physical Exam, emphasis on neurological and otological components
* Detailed assessment of coronary artery disease risk factors using Multiple-Risk-Factor Assessment[1,2] (age, family history, lipid profile, blood pressure, diabetic screening, smoking history). Further cardiac screening may be indicated based on risk factor assessment.
* Resting EKG
* Chest X-ray
* Urinalysis
* Any further tests deemed necessary by the physician

ss) Periodic re-examination over age 40 (every 3 years); over age 60 (every 2 years):

* Medical History
* Complete Physical Exam, emphasis on neurological and otological components
* Detailed assessment of coronary artery disease risk factors using Multiple-Risk-Factor Assessment[1] (age, family history, lipid profile, blood pressure, diabetic screening, smoking history). Further cardiac screening may be indicated based on risk factor assessment.
* Resting EKG
* Urinalysis
* Any further tests deemed necessary by the physician

tt) Physician's Written Report

1. After any medical examination relating to the individual's fitness to dive, the organizational member shall obtain a written report prepared by the examining physician that shall contain the examining physician's opinion of the individual's fitness to dive, including any recommended restrictions or limitations. This report will be reviewed by the DCB.
2. The organizational member shall make a copy of the physician's written report available to the individual.

[1] Grundy, R.J. et. al. 1999. Assessment of Cardiovascular Risk by Use of Multiple-Risk-Factor Assessment Equations. AHA/ACC Scientific Statement. http://www.acc.org/clinical/consensus/risk/risk1999.pdf
[2] Bove, A.A. 2011. The cardiovascular system and diving risk. *Undersea and Hyperbaric Medicine* 38(4): 261-269.

Volume 2

Sections 7.00 through 12.00
Required Only When Conducting Described Diving Activities
and
Organizational Member Specific Sections

SECTION 7.00 NITROX DIVING GUIDELINES

The following guidelines address the use of nitrox by scientific divers under the auspices of an AAUS Organizational Member. Nitrox is defined for these guidelines as breathing mixtures composed predominately of nitrogen and oxygen, most commonly produced by the addition of oxygen or the removal of nitrogen from air.

7.10 Prerequisites

Eligibility

Only a certified Scientific Diver or Scientific Diver In Training (Sections 4.00 and 5.00) diving under the auspices of a member organization is eligible for authorization to use nitrox. After completion, review and acceptance of application materials, training and qualification, an applicant will be authorized to use nitrox within their depth authorization, as specified in Section 5.40.

Application and Documentation

Application and documentation for authorization to use nitrox should be made on forms specified by the Diving Control Board.

7.20 Requirements for Authorization to Use Nitrox

Submission of documents and participation in aptitude examinations does not automatically result in authorization to use nitrox. The applicant must convince the DSO and members of the DCB that they are sufficiently skilled and proficient. The signature of the DSO on the authorization form will acknowledge authorization. After completion of training and evaluation, authorization to use nitrox may be denied to any diver who does not demonstrate to the satisfaction of the DSO or DCB the appropriate judgment or proficiency to ensure the safety of the diver and dive buddy.

Prior to authorization to use nitrox, the following minimum requirements should be met:

Training

The diver must complete additional theoretical and practical training beyond the Scientific Diver In Training air certification level, to the satisfaction of the member organizations DSO and DCB (Section 7.30).

Examinations

Each diver should demonstrate proficiency in skills and theory in written, oral, and practical examinations covering:

a) Written examinations covering the information presented in the classroom training session(s) (i.e., gas theory, oxygen toxicity, partial pressure determination, etc.);

b) Practical examinations covering the information presented in the practical training session(s) (i.e., gas analysis, documentation procedures, etc.);

c) Openwater checkout dives, to appropriate depths, to demonstrate the application of theoretical and practical skills learned.

Minimum Activity to Maintain Authorization

The diver should log at least one nitrox dive per year. Failure to meet the minimum activity level may be cause for restriction or revocation of nitrox authorization.

7.30 Nitrox Training Guidelines

Training in these guidelines should be in addition to training for Diver-In-Training authorization (Section 4.00). It may be included as part of training to satisfy the Scientific Diver training requirements (Section 5.30).

Classroom Instruction

d) Topics should include, but are not limited to: review of previous training; physical gas laws pertaining to nitrox; partial pressure calculations and limits; equivalent air depth (EAD) concept and calculations; oxygen physiology and oxygen toxicity; calculation of oxygen exposure and maximum safe operating depth (MOD); determination of decompression schedules (both by EAD method using approved air dive tables, and using approved nitrox dive tables); dive planning and emergency procedures; mixing procedures and calculations; gas analysis; personnel requirements; equipment marking and maintenance requirements; dive station requirements.

e) DCB may choose to limit standard nitrox diver training to procedures applicable to diving, and subsequently reserve training such as nitrox production methods, oxygen cleaning, and dive station topics to divers requiring specialized authorization in these areas.

Practical Training

The practical training portion will consist of a review of skills as stated for scuba (Section 4.00), with additional training as follows:

a) Oxygen analysis of nitrox mixtures.

b) Determination of MOD, oxygen partial pressure exposure, and oxygen toxicity time limits, for various nitrox mixtures at various depths.

c) Determination of nitrogen-based dive limits status by EAD method using air dive tables, and/or using nitrox dive tables, as approved by the DCB.

d) Nitrox dive computer use may be included, as approved by the DCB.

Written Examination (based on classroom instruction and practical training)

Before authorization, the trainee should successfully pass a written examination demonstrating knowledge of at least the following:

a) Function, care, use, and maintenance of equipment cleaned for nitrox use.

b) Physical and physiological considerations of nitrox diving (ex.: O_2 and CO_2 toxicity).

c) Diving regulations and procedures as related to nitrox diving, either scuba or surface-supplied (depending on intended mode).

d) Given the proper information, calculation of:

1. Equivalent air depth (EAD) for a given fO_2 and actual depth;
2. pO_2 exposure for a given fO_2 and depth;
3. Optimal nitrox mixture for a given pO_2 exposure limit and planned depth;
4. Maximum operational depth (MOD) for a given mix and pO_2 exposure limit;
5. For nitrox production purposes, percentages/psi of oxygen present in a given mixture, and psi of each gas required to produce a fO_2 by partial pressure mixing.

e) Dive table and dive computer selection and usage;

f) Nitrox production methods and considerations.

g) Oxygen analysis.

h) Nitrox operational guidelines (Section 7.40), dive planning, and dive station components.

Openwater Dives

A minimum of two supervised openwater dives using nitrox is required for authorization. The mode used in the dives should correspond to the intended application (i.e., scuba or surface-supplied). If the MOD for the mix being used can be exceeded at the training location, direct, in-water supervision is required.

Surface-Supplied Training

All training as applied to surface-supplied diving (practical, classroom, and openwater) will follow the member organization's surface-supplied diving standards, including additions listed in Section 11.60.

7.40 Scientific Nitrox Diving Regulations

Dive Personnel Requirements

a) Nitrox Diver In Training - A Diver In Training, who has completed the requirements of Section 4.00 and the training and authorization sections of these guidelines, may be authorized by the DSO to use nitrox under the direct supervision a Scientific Diver who also holds nitrox authorization. Dive depths should be restricted to those specified in the diver's authorization.

b) Scientific Diver - A Scientific Diver who has completed the requirements of Section 5.00 and the training and authorization sections of these guidelines, may be authorized by the DSO to use nitrox. Depth authorization to use nitrox should be the same as those specified in the diver's authorization, as described in Section. 5.40.

c) Lead Diver - On any dive during which nitrox will be used by any team member, the Lead Diver should be authorized to use nitrox, and hold appropriate authorizations required for the dive, as specified in AAUS Standards. Lead Diver authorization for nitrox dives by the DSO and/or DCB should occur as part of the dive plan approval process.

In addition to responsibilities listed in Section 1.20, the Lead Diver should:

1. As part of the dive planning process, verify that all divers using nitrox on a dive are properly qualified and authorized;

2. As part of the pre-dive procedures, confirm with each diver the nitrox mixture the diver is using, and establish dive team maximum depth and time limits, according to the shortest time limit or shallowest depth limit among the team members.

3. The Lead Diver should also reduce the maximum allowable pO_2 exposure limit for the dive team if on-site conditions so indicate (see Sec. 7.42.).

Dive Parameters

a) Oxygen Exposure Limits

1. The inspired oxygen partial pressure experienced at depth should not exceed 1.6 ATA. All dives performed using nitrox breathing mixtures should comply with the current *NOAA Diving Manual* "Oxygen Partial Pressure Limits for 'Normal' Exposures"

2. The maximum allowable exposure limit should be reduced in cases where cold or strenuous dive conditions, or extended exposure times are expected. The DCB should consider this in the review of any dive plan application, which proposes to use nitrox. The Lead Diver should also review on-site conditions and reduce the allowable pO_2 exposure limits if conditions indicate.

3. If using the equivalent air depth (EAD) method the maximum depth of a dive should be based on the oxygen partial pressure for the specific nitrox breathing mix to be used.

b) Bottom Time Limits

1. Maximum bottom time should be based on the depth of the dive and the nitrox mixture being used.

2. Bottom time for a single dive should not exceed the NOAA maximum allowable "Single Exposure Limit" for a given oxygen partial pressure, as listed in the current NOAA Diving Manual.

c) Dive Tables and Gases

1. A set of DCB approved nitrox dive tables should be available at the dive site.

2. When using the equivalent air depth (EAD) method, dives should be conducted using air dive tables approved by the DCB.

3. If nitrox is used to increase the safety margin of air-based dive tables, the MOD and oxygen exposure and time limits for the nitrox mixture being dived should not be exceeded

4. Breathing mixtures used while performing in-water decompression, or for bail-out purposes, should contain the same or greater oxygen content as that being used during the dive, within the confines of depth limitations and oxygen partial pressure limits set forth in Section 7.40 Dive Parameters.

d) Nitrox Dive Computers

1. Dive computers may be used to compute decompression status during nitrox dives. Manufacturers' guidelines and operations instructions should be followed.

2. Use of Nitrox dive computers should comply with dive computer guidelines included in the AAUS Standards.

3. Nitrox dive computer users should demonstrate a clear understanding of the display, operations, and manipulation of the unit being used for nitrox diving prior to using the computer, to the satisfaction of the DSO or designee.

4. If nitrox is used to increase the safety margin of an air-based dive computer, the MOD and oxygen exposure and time limits for the nitrox mixture being dived shall not be exceeded.

5. Dive computers capable of pO_2 limit and fO_2 adjustment should be checked by the diver prior to the start each dive to assure compatibility with the mix being used.

e) Repetitive Diving

1. Repetitive dives using nitrox mixtures should be performed in compliance with procedures required of the specific dive tables used.

2. Residual nitrogen time should be based on the EAD for the specific nitrox mixture to be used on the repetitive dive, and not that of the previous dive.

3. The total cumulative exposure (bottom time) to a partial pressure of oxygen in a given 24 hour period should not exceed the current *NOAA Diving Manual* 24-hour Oxygen Partial Pressure Limits for "Normal" Exposures.

4. When repetitive dives expose divers to different oxygen partial pressures from dive to dive, divers should account for accumulated oxygen exposure from previous dives when determining acceptable exposures for repetitive dives. Both acute (CNS) and chronic (pulmonary) oxygen toxicity concerns should be addressed.

f) Oxygen Parameters

1. Authorized Mixtures - Mixtures meeting the criteria outlined in Section 7.40 may be used for nitrox diving operations, upon approval of the DCB.

2. Purity - Oxygen used for mixing nitrox-breathing gas should meet the purity levels for "Medical Grade" (U.S.P.) or "Aviator Grade" standards.

In addition to the AAUS Air Purity Guidelines (Section 3.60), the following standard should be met for breathing air that is either:

a. Placed in contact with oxygen concentrations greater than 40%.

b. Used in nitrox production by the partial pressure mixing method with gas mixtures containing greater than 40% oxygen as the enriching agent.

Air Purity: CGA Grade E (Section 3.60)	
Condensed Hydrocarbons	5mg/m^3
Hydrocarbon Contaminants	No greater than 0.1 mg/m^3

g) Gas Mixing and Analysis for Organizational Members

1. Personnel Requirements

a. Individuals responsible for producing and/or analyzing nitrox mixtures should be knowledgeable and experienced in all aspects of the technique.

b. Only those individuals approved by the DSO and/or DCB should be responsible for mixing and/or analyzing nitrox mixtures.

2. Production Methods - It is the responsibility of the DCB to approve the specific nitrox production method used.

3. Analysis Verification by User

a. It is the responsibility of each diver to analyze prior to the dive the oxygen content of his/her scuba cylinder and acknowledge in writing the following information for each cylinder: fO_2, MOD, cylinder pressure, date of analysis, and user's name.

b. Individual dive log reporting forms should report fO_2 of nitrox used, if different than 21%.

7.50 Nitrox Diving Equipment

All of the designated equipment and stated requirements regarding scuba equipment required in the AAUS Standards should apply to nitrox scuba operations. Additional minimal equipment necessary for nitrox diving operations includes:

- Labeled SCUBA Cylinders
- Oxygen Analyzers

Oxygen Cleaning and Maintenance Requirements

a) Requirement for Oxygen Service

1. All equipment, which during the dive or cylinder filling process is exposed to concentrations greater than 40% oxygen at pressures above 150 psi, should be cleaned and maintained for oxygen service.

2. Equipment used with oxygen or mixtures containing over 40% by volume oxygen shall be designed and maintained for oxygen service. Oxygen systems over 125 psig shall have slow-opening shut-off valves. This should include the following equipment: scuba cylinders, cylinder valves, scuba and other regulators, cylinder pressure gauges, hoses, diver support equipment, compressors, and fill station components and plumbing.

b) Scuba Cylinder Identification Marking

Scuba cylinders to be used with nitrox mixtures should have the following identification documentation affixed to the cylinder.

1. Cylinders should be marked "NITROX", or "EANx", or "Enriched Air".
2. Nitrox identification color-coding should include a 4-inch wide green band around the cylinder, starting immediately below the shoulder curvature. If the cylinder is not yellow, the green band should be bordered above and below by a 1-inch yellow band.
3. The alternate marking of a yellow cylinder by painting the cylinder crown green and printing the word "NITROX" parallel to the length of the cylinder in green print is acceptable.
4. Other markings, which identify the cylinder as containing gas mixes other than Air, may be used as the approval of the DCB.
5. A contents label should be affixed, to include the current fO_2, date of analysis, and MOD.
6. The cylinder should be labeled to indicate whether the cylinder is prepared for oxygen or nitrox mixtures containing greater than 40% oxygen.

c) Regulators - Regulators to be used with nitrox mixtures containing greater than 40% oxygen should be cleaned and maintained for oxygen service, and marked in an identifying manner.

d) Other Support Equipment

1. An oxygen analyzer is required which is capable of determining the oxygen content in the scuba cylinder. Two analyzers are recommended to reduce the likelihood of errors due to a faulty analyzer. The analyzer should be capable of reading a scale of 0 to 100% oxygen, within 1% accuracy.
2. All diver and support equipment should be suitable for the fO_2 being used.

e) Compressor system

1. Compressor/filtration system must produce oil-free air.
2. An oil-lubricated compressor placed in service for a nitrox system should be checked for oil and hydrocarbon contamination at least quarterly.

f) Fill Station Components - All components of a nitrox fill station that will contact nitrox mixtures containing greater than 40% oxygen should be cleaned and maintained for oxygen service. This includes cylinders, whips, gauges, valves, and connecting lines.

SECTION 8.00 AQUARIUM DIVING OPERATIONS

8.10 General Policy

Section 8.00 applies to scientific aquarium divers only.

Definition - A scientific aquarium diver is a scientific diver who is diving solely within an aquarium. An aquarium is a shallow, confined body of water, which is operated by or under the control of an institution and is used for the purposes of specimen exhibit, education, husbandry, or research.

It is recognized that within scientific aquarium diving there are environments and equipment that fall outside the scope of those addressed in this standard. In those circumstances it is the responsibility of the organizational member's Dive Control Board to establish the requirements and protocol under which diving will be safely conducted.

Note: All of the standards set forth in other sections of this standard shall apply, except as otherwise provided in this section.

8.20 The Buddy System In Scientific Aquarium Diving

All scuba diving activities in the confined environment of an aquarium shall be conducted in accordance with the buddy system, whereby both divers, or a diver and a tender as provided below, are always in visual contact with one another, can always communicate with one another, and can always render prompt and effective assistance either in response to an emergency or to prevent an emergency.

A diver and tender comprise a buddy team in the confined environment of an aquarium only when the maximum depth does not exceed 30 feet, and there are no overhead obstructions or entanglement hazards for the diver, and the tender is equipped, ready and able to conduct or direct a prompt and effective in-water retrieval of the diver at all times during the dive.

8.30 Diving Equipment

Section 3.20 is modified to read as follows:

In an aquarium of a known maximum obtainable depth:

1. A depth indicator is not required, except that a repetitive diver shall use the same computer used on any prior dive.
2. Only one buddy must be equipped with a timing device.
3. The maximum obtainable depth of the aquarium shall be used as the diving depth.

8.40 Scientific Aquarium Diver Certification

A Scientific Aquarium Diver is a certification enabling the qualified diver to participate in scientific diving in accordance with Section 8.00 as provided below.

All of the standards set forth in sections 4.0 and 5.0 of this standard shall apply, except that Section 5.30 of this standard is modified to read as follows:

Practical training shall include at least 12 supervised aquarium dives for a cumulative bottom time of 6 hours. No more than 3 of these dives shall be made in 1 day.

8.50 Scientific Aquarium Diving Using Other Diving Technology

Surface Supplied Scientific Aquarium Diving

Definition: For purposes of scientific aquarium diving, surface supplied diving is described as a mode of diving using open circuit, surface supplied compressed gas which is provided to the diver at the dive location and may or may not include voice communication with the surface tender.

a) Divers using the surface supplied mode shall be equipped with a diver-carried independent reserve breathing gas supply.

Scientific aquarium divers using conventional scuba masks, full-face masks, or non-lockdown type helmets are exempt from this standard provided:

1. There are no overhead obstructions or entanglements.
2. The diver is proficient in performing a Controlled Emergency Swimming Ascent from at least as deep as the maximum depth of the aquarium.
3. The diver is proficient in performing out of air emergency drills, including ascent and mask/helmet removal.
4. Each surface supplied diver shall be hose-tended by a separate dive team member while in the water. Scientific aquarium divers are exempt from this standard, provided the tender is monitoring only one air source, there is mutual assistance between divers and there are no overhead obstructions or entanglements.

b) Divers using the surface supplied mode shall maintain communication with the surface tender. The surface supplied breathing gas supply (volume and intermediate pressure) shall be sufficient to support all surface supplied divers in the water for the duration of the planned dive.

c) During surface supplied diving operations when only one diver is in the water, there must be a standby diver in attendance at the dive location. Scientific aquarium divers are exempt from this standard, provided the tender is equipped, ready and able to conduct a prompt and effective in-water retrieval of the diver at all times during the dive."

d) Surface supplied equipment must be configured to allow retrieval of the diver by the surface tender without risk of interrupting air supply to the diver.

e) All surface supplied applications used for scientific aquarium diving shall have a non-return valve at the attachment point between helmet or mask hose, which shall close readily and positively.

SECTION 9.00 STAGED DECOMPRESSION DIVING

Decompression diving shall be defined as any diving during which the diver cannot perform a direct return to the surface without performing a mandatory decompression stop to allow the release of inert gas from the diver's body.

The following procedures shall be observed when conducting dives requiring planned decompression stops.

9.10 Minimum Experience and Training Requirements

a) Prerequisites:

1. Scientific Diver qualification according to Section 5.00.
2. Minimum of 100 logged dives.
3. Demonstration of the ability to safely plan and conduct dives deeper than 100 feet.
4. Nitrox certification/authorization according to AAUS Section 7.00 recommended.

b) Training shall be appropriate for the conditions in which dive operations are to be conducted.

c) Minimum Training shall include the following:

1. A minimum of 6 hours of classroom training to ensure theoretical knowledge to include: physics and physiology of decompression; decompression planning and procedures; gas management; equipment configurations; decompression method, emergency procedures.
2. It is recommended that at least one training session be conducted in a pool or sheltered water setting, to cover equipment handling and familiarization, swimming and buoyancy control, to estimate gas consumption rates, and to practice emergency procedures.
3. At least 6 open-water training dives simulating/requiring decompression shall be conducted, emphasizing planning and execution of required decompression dives, and including practice of emergency procedures.
4. Progression to greater depths shall be by 4-dive increments at depth intervals as specified in Section 5.40.
5. No training dives requiring decompression shall be conducted until the diver has demonstrated acceptable skills under simulated conditions.

6. The following are the minimum skills the diver must demonstrate proficiently during dives simulating and requiring decompression:
    - Buoyancy control
    - Proper ascent rate
    - Proper depth control
    - Equipment manipulation
    - Stage/decompression bottle use as pertinent to planned diving operation
    - Buddy skills
    - Gas management
    - Time management
    - Task loading
    - Emergency skills
7. Divers shall demonstrate to the satisfaction of the DSO or the DSO’s designee proficiency in planning and executing required decompression dives appropriate to the conditions in which diving operations are to be conducted.
8. Upon completion of training, the diver shall be authorized to conduct required decompression dives with DSO approval.

9.20 Minimum Equipment Requirements

a) Valve and regulator systems for primary (bottom) gas supplies shall be configured in a redundant manner that allows continuous breathing gas delivery in the event of failure of any one component of the regulator/valve system.

b) Cylinders with volume and configuration adequate for planned diving operations.

c) One of the second stages on the primary gas supply shall be configured with a hose of adequate length to facilitate effective emergency gas sharing in the intended environment.

d) Minimum dive equipment shall include:

1. Snorkel is optional at the DCB's discretion, as determined by the conditions and environment.
2. Diver location devices adequate for the planned diving operations and environment.
3. Compass

e) Redundancy in the following components is desirable or required at the discretion of the DCB or DSO:

1. Decompression Schedules
2. Dive Timing Devices
3. Depth gauges
4. Buoyancy Control Devices
5. Cutting devices
6. Lift bags and line reels

9.30 Minimum Operational Requirements

a) Approval of dive plan applications to conduct required decompression dives shall be on a case-by-case basis.

b) The maximum pO_2 to be used for planning required decompression dives is 1.6. It is recommended that a pO_2 of less than 1.6 be used during bottom exposure.

c) Diver's gas supplies shall be adequate to meet planned operational requirements and foreseeable emergency situations.

d) Decompression dives may be planned using dive tables, dive computers, and/or PC software approved by the DSO/DCB.

e) Breathing gases used while performing in-water decompression shall contain the same or greater oxygen content as that used during the bottom phase of the dive.

f) The dive team prior to each dive shall review emergency procedures appropriate for the planned dive.

g) If breathing gas mixtures other than air are used for required decompression, their use shall be in accordance with those regulations set forth in the appropriate sections of this standard.

h) The maximum depth for required decompression using air as the bottom gas shall be 190 feet.

i) Use of additional nitrox and/or high-oxygen fraction decompression mixtures as travel and decompression gases to decrease decompression obligations is encouraged.

j) Use of alternate inert gas mixtures to limit narcosis is encouraged for depths greater than 150 feet.

k) If a period of more than 6 months has elapsed since the last mixed gas dive, a series of progressive workup dives to return the diver(s) to proficiency status prior to the start of project diving operations are recommended.

l) Mission specific workup dives are recommended.

SECTION 10.00 MIXED GAS DIVING

Mixed gas diving is defined as dives done while breathing gas mixes containing proportions greater than 1% by volume of an inert gas other than nitrogen.

10.10 Minimum Experience and Training Requirements

a) Prerequisites:

1. Nitrox certification and authorization (Section 7.00)
2. If the intended use entails required decompression stops, divers will be previously certified and authorized in decompression diving (Section 9.00).
3. Divers shall demonstrate to the DCB's satisfaction skills, knowledge, and attitude appropriate for training in the safe use of mixed gases.

b) Classroom training including:

1. Review of topics and issues previously outlined in nitrox and required decompression diving training as pertinent to the planned operations.
2. The use of helium or other inert gases, and the use of multiple decompression gases.
3. Equipment configurations
4. Mixed gas decompression planning
5. Gas management planning
6. Thermal considerations
7. END determination
8. Mission planning and logistics
9. Emergency procedures
10. Mixed gas production methods
11. Methods of gas handling and cylinder filling
12. Oxygen exposure management
13. Gas analysis
14. Mixed gas physics and physiology

c) Practical Training:

1. Confined water session(s) in which divers demonstrate proficiency in required skills and techniques for proposed diving operations.
2. A minimum of 6 open water training dives.
3. At least one initial dive shall be in 130 feet or less to practice equipment handling and emergency procedures.
4. Subsequent dives will gradually increase in depth, with a majority of the training dives being conducted between 130 feet and the planned operational depth.
5. Planned operational depth for initial training dives shall not exceed 260 feet.
6. Diving operations beyond 260 feet requires additional training dives.

10.20 Equipment and Gas Quality Requirements

a) Equipment requirements shall be developed and approved by the DCB, and met by divers, prior to engaging in mixed-gas diving. Equipment shall meet other pertinent requirements set forth elsewhere in this standard.

b) The quality of inert gases used to produce breathing mixtures shall be of an acceptable grade for human consumption.

10.30 Minimum Operational Requirements

a) Approval of dive plan applications to conduct mixed gas dives shall be on a case-by-case basis.

b) All applicable operational requirements for nitrox and decompression diving shall be met.

c) The maximum pO_2 to be used for planning required decompression dives is 1.6. It is recommended that a pO_2 of less than 1.6 be used during bottom exposure.

d) Maximum planned Oxygen Toxicity Units (OTU) will be considered based on mission duration.

e) Divers decompressing on high-oxygen concentration mixtures shall closely monitor one another for signs of acute oxygen toxicity.

If a period of more than 6 months has elapsed since the last mixed gas dive, a series of progressive workup dives to return the diver(s) to proficiency status prior to the start of project diving operations are recommended.

SECTION 11.00 OTHER DIVING TECHNOLOGY

Certain types of diving, some of which are listed below, require equipment or procedures that require training. Supplementary guidelines for these technologies are in development by the AAUS. Organizational member's using these, must have guidelines established by their Diving Control Board. Divers shall comply with all scuba diving procedures in this standard unless specified.

11.10 Blue Water Diving

Blue water diving is defined as diving in open water where the bottom is generally greater than 200 feet deep. It requires special training and the use of multiple-tethered diving techniques. Specific guidelines that should be followed are outlined in "Blue Water Diving Guidelines" (California Sea Grant Publ. No. T-CSGCP-014).

11.20 Ice And Polar Diving

Divers planning to dive under ice or in polar conditions should use the following: "Guidelines for Conduct of Research Diving", National Science Foundation, Division of Polar Programs, 1990.

11.30 Overhead Environments

Where an enclosed or confined space is not large enough for two divers, a diver shall be stationed at the underwater point of entry and an orientation line shall be used.

11.40 Saturation Diving

If using open circuit compressed air scuba in saturation diving operations, divers shall comply with the saturation diving guidelines of the organizational member.

11.50 Hookah

While similar to Surface Supplied in that the breathing gas is supplied from the surface by means of a pressurized hose, the supply hose does not require a strength member, pneumofathometer hose, or communication line. Hookah equipment may be as simple as a long hose attached to a standard scuba cylinder supplying a standard scuba second stage. The diver is responsible for the monitoring his/her own depth, time, and diving profile.

11.60 Surface Supplied Diving

Surface Supplied: Dives where the breathing gas is supplied from the surface by means of a pressurized umbilical hose. The umbilical generally consists of a gas supply hose, strength member, pneumofathometer hose, and communication line. The umbilical supplies a helmet or full-face mask. The diver may rely on the tender at the surface to keep up with the divers' depth, time and diving profile.

SECTION 12.0 REBREATHERS

This section defines specific considerations regarding the following issues for the use of rebreathers:

- Training and/or experience verification requirements for authorization
- Equipment requirements
- Operational requirements and additional safety protocols to be used

Application of this standard is in addition to pertinent requirements of all other sections of the AAUS Standards for Scientific Diving, Volumes 1 and 2.

For rebreather dives that also involve staged decompression and/or mixed gas diving, all requirements for each of the relevant diving modes shall be met. Diving Control Board reserves the authority to review each application of all specialized diving modes, and include any further requirements deemed necessary beyond those listed here on a case-by-case basis.

No diver shall conduct planned operations using rebreathers without prior review and approval of the DCB.

In all cases, trainers shall be qualified for the type of instruction to be provided. Training shall be conducted by agencies or instructors approved by DSO and DCB.

12.10 Definitions and General Information

a) Rebreathers are defined as any device that recycles some or all of the exhaled gas in the breathing loop and returns it to the diver. Rebreathers maintain levels of oxygen and carbon dioxide that support life by metered injection of oxygen and chemical removal of carbon dioxide. These characteristics fundamentally distinguish rebreathers from open-circuit life support systems, in that the breathing gas composition is dynamic rather than fixed.

1. Advantages of rebreathers may include increased gas utilization efficiencies that are often independent of depth, extended no-decompression bottom times and greater decompression efficiency, and reduction or elimination of exhaust bubbles that may disturb aquatic life or sensitive environments.

2. Disadvantages of rebreathers include high cost and, in some cases, a high degree of system complexity and reliance on instrumentation for gas composition control and monitoring, which may fail. The diver is more likely to experience hazardous levels of hypoxia, hyperoxia, or hypercapnia, due to user error or equipment malfunction, conditions which may lead to underwater blackout and drowning. Inadvertent flooding of the breathing loop and wetting of the carbon dioxide absorbent may expose the diver to ingestion of an alkaline slurry ("caustic cocktail").

3. An increased level of discipline and attention to rebreather system status by the diver is required for safe operation, with a greater need for self-reliance. Rebreather system design and operation varies significantly between make and model. For these reasons when evaluating any dive plan incorporating rebreathers, risk-management emphasis should be placed on the individual qualifications of the diver on the specific rebreather make and model to be used, in addition to specific equipment requirements and associated operational protocols.

b) Oxygen Rebreathers. Oxygen rebreathers recycle breathing gas, consisting of pure oxygen, replenishing the oxygen metabolized by the diver. Oxygen rebreathers are generally the least complicated design, but are normally limited to a maximum operation depth of 20fsw due to the risk of unsafe hyperoxic exposure.

c) Semi-Closed Circuit Rebreathers. Semi-closed circuit rebreathers (SCR) recycle the majority of exhaled breathing gas, venting a portion into the water and replenishing it with a constant or variable amount of a single oxygen-enriched gas mixture. Gas addition and venting is balanced against diver metabolism to maintain safe oxygen levels by means which differ between SCR models, but the mechanism usually provides a semi-constant fraction of oxygen (FO_2) in the breathing loop at all depths, similar to open-circuit SCUBA.

d) Closed-Circuit Mixed Gas Rebreathers. Closed-circuit mixed gas rebreathers (CCR) recycle all of the exhaled gas and replace metabolized oxygen via an electronically controlled valve, governed by electronic oxygen sensors. Manual oxygen addition is available as a diver override, in case of electronic system failure. A separate inert gas source (diluent), usually containing primarily air, heliox, or trimix, is used to maintain oxygen levels at safe levels when diving below 20fsw. CCR systems operate to maintain a constant oxygen partial pressure (PPO_2) during the dive, regardless of depth.

12.20 Prerequisites

Specific training requirements for use of each rebreather model shall be defined by DCB on a case-by-case basis. Training shall include factory-recommended requirements, but may exceed this to prepare for the type of mission intended (e.g., staged decompression or heliox/trimix CCR diving).

Training Prerequisites

a) Active scientific diver status, with depth qualification sufficient for the type, make, and model of rebreather, and planned application.

b) Completion of a minimum of 50 open-water dives on SCUBA.

c) For SCR or CCR, a minimum 100-fsw-depth qualification is generally recommended, to ensure the diver is sufficiently conversant with the complications of deeper diving. If the sole expected application for use of rebreathers is shallower than this, a lesser depth qualification may be allowed with the approval of the DCB.

d) Nitrox training. Training in use of nitrox mixtures containing 25% to 40% oxygen is required. Training in use of mixtures containing 40% to 100% oxygen may be required, as needed for the planned application and rebreather system. Training may be provided as part of rebreather training.

Training

Successful completion of the following training program qualifies the diver for rebreather diving using the system on which the diver was trained, in depths of 130fsw and shallower, for dives that do not require decompression stops, using nitrogen/oxygen breathing media.

a) Satisfactory completion of a rebreather training program authorized or recommended by the manufacturer of the rebreather to be used, or other training approved by the DCB. Successful completion of training does not in itself authorize the diver to use rebreathers. The diver must demonstrate to the DCB or its designee that the diver possesses the proper attitude, judgment, and discipline to safely conduct rebreather diving in the context of planned operations.

b) Classroom training shall include:

1. A review of those topics of diving physics and physiology, decompression management, and dive planning included in prior scientific diver, nitrox, staged decompression and/or mixed gas training, as they pertain to the safe operation of the selected rebreather system and planned diving application.

2. In particular, causes, signs and symptoms, first aid, treatment and prevention of the following must be covered:

- Hyperoxia (CNS and Pulmonary Oxygen Toxicity)
- Middle Ear Oxygen Absorption Syndrome (oxygen ear)
- Hyperoxia-induced myopia
- Hypoxia
- Hypercapnia
- Inert gas narcosis
- Decompression sickness

3. Rebreather-specific information required for the safe and effective operation of the system to be used, including:

- System design and operation, including:
- Counterlung(s)
- CO_2 scrubber
- CO_2 absorbent material types, activity characteristics, storage, handling and disposal
- Oxygen control system design, automatic and manual
- Diluent control system, automatic and manual (if any)
- Pre-dive set-up and testing
- Post-dive break-down and maintenance
- Oxygen exposure management
- Decompression management and applicable decompression tracking methods
- Dive operations planning
- Problem recognition and management, including system failures leading to hypoxia, hyperoxia, hypercapnia, flooded loop, and caustic cocktail
- Emergency protocols and bailout procedures

Practical Training (with model of rebreather to be used)

a) A minimum number of hours of underwater time.

Type	Pool/Confined Water	O/W Training	O/W Supervised
Oxygen Rebreather	1 dive, 90 min	4 dives, 120 min.*	2 dives, 60 min
Semi-Closed Circuit	1 dive, 90-120 min	4 dives, 120 min.**	4 dives, 120 min
Closed-Circuit	1 dive, 90-120 min	8 dives, 380 min.***	4 dives, 240 min

* Dives should not exceed 20 fsw.

** First two dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least o dive in the 80 to 100 fsw range.

*** Total underwater time (pool and open water) of approximately 500 minutes. First two open water dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least 2 dives in the 100 to 130 fsw range.

b) Amount of required in-water time should increase proportionally to the complexity of rebreather system used.

c) Training shall be in accordance with the manufacturer's recommendations.

Practical Evaluations

Upon completion of practical training, the diver must demonstrate to the DCB or its designee proficiency in pre-dive, dive, and post-dive operational procedures for the particular model of rebreather to be used. Skills shall include, at a minimum:

- Oxygen control system calibration and operation checks
- Carbon dioxide absorbent canister packing
- Supply gas cylinder analysis and pressure check
- Test of one-way valves
- System assembly and breathing loop leak testing
- Pre-dive breathing to test system operation
- In-water leak checks
- Buoyancy control during descent, bottom operations, and ascent
- System monitoring and control during descent, bottom operations, and ascent
- Proper interpretation and operation of system instrumentation (PO2 displays, dive computers, gas supply pressure gauges, alarms, etc, as applicable)
- Unit removal and replacement on the surface.
- Bailout and emergency procedures for self and buddy, including:
- System malfunction recognition and solution
- Manual system control
- Flooded breathing loop recovery (if possible)
- Absorbent canister failure
- Alternate bailout options
- Symptom recognition and emergency procedures for hyperoxia, hypoxia, and hypercapnia
- Proper system maintenance, including:
- Full breathing loop disassembly and cleaning (mouthpiece, check-valves, hoses, counterlung, absorbent canister, etc.)
- Oxygen sensor replacement (for SCR and CCR)
- Other tasks required by specific rebreather models

Written Evaluation

A written evaluation approved by the DCB with a pre-determined passing score, covering concepts of both classroom and practical training, is required.

Supervised Rebreather Dives

Upon successful completion of open water training dives, the diver is authorized to conduct a series of supervised rebreather dives, during which the diver gains additional experience and proficiency.

a) Supervisor for these dives should be the DSO or designee, and should be an active scientific diver experienced in diving with the make/model of rebreather being used.

b) Dives at this level may be targeted to activities associated with the planned science diving application. See the following table for number and cumulative water time for different rebreather types.

Type	Pool/Confined Water	O/W Training	O/W Supervised
Oxygen Rebreather	1 dive, 90 min	4 dives, 120 min.*	2 dives, 60 min
Semi-Closed Circuit	1 dive, 90-120 min	4 dives, 120 min.**	4 dives, 120 min
Closed-Circuit	1 dive, 90-120 min	8 dives, 380 min.***	4 dives, 240 min

* Dives should not exceed 20 fsw.
** First two dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least dive in the 80 to 100 fsw range.
*** Total underwater time (pool and open water) of approximately 500 minutes. First two open water dives should not exceed 60 fsw. Subsequent dives should be at progressively greater depths, with at least 2 dives in the 100 to 130 fsw range.

c) Maximum ratio of divers per designated dive supervisor is 4:1. The supervisor may dive as part of the planned operations.

Extended Range, Required Decompression and Helium-Based Inert Gas

Rebreather dives involving operational depths in excess of 130 fsw, requiring staged decompression, or using diluents containing inert gases other than nitrogen are subject to additional training requirements, as determined by DCB on a case-by-case basis. Prior experience with required decompression and mixed gas diving using open-circuit SCUBA is desirable, but is not sufficient for transfer to dives using rebreathers without additional training.

a) As a prerequisite for training in staged decompression using rebreathers, the diver shall have logged a minimum of 25 hours of underwater time on the rebreather system to be used, with at least 10 rebreather dives in the 100 fsw to 130 fsw range.

b) As a prerequisite for training for use of rebreathers with gas mixtures containing inert gas other than nitrogen, the diver shall have logged a minimum of 50 hours of underwater time on the rebreather system to be used and shall have completed training in stage decompression methods using rebreathers. The diver shall have completed at least 12 dives requiring staged decompression on the rebreather model to be used, with at least 4 dives near 130 fsw.

c) Training shall be in accordance with standards for required-decompression and mixed gas diving, as applicable to rebreather systems, starting at the130 fsw level.

Maintenance of Proficiency

a) To maintain authorization to dive with rebreathers, an authorized diver shall make at least one dive using a rebreather every 8 weeks. For divers authorized for the conduct of extended range, stage decompression or mixed-gas diving, at least one dive per month should be made to a depth near 130 fsw, practicing decompression protocols.

b) For a diver in arrears, the DCB shall approve a program of remedial knowledge and skill tune-up training and a course of dives required to return the diver to full authorization. The extent of this program should be directly related to the complexity of the planned rebreather diving operations.

12.30 Equipment Requirements

General Requirements

a) Only those models of rebreathers specifically approved by DCB shall be used.

b) Rebreathers should be manufactured according to acceptable Quality Control/Quality Assurance protocols, as evidenced by compliance with the essential elements of ISO 9004. Manufacturers should be able to provide to the DCB supporting documentation to this effect.

c) Unit performance specifications should be within acceptable levels as defined by standards of a recognized authority (CE, US Navy, Royal Navy, NOAA, etc…).

d) Prior to approval, the manufacturer should supply the DCB with supporting documentation detailing the methods of specification determination by a recognized third-party testing agency, including unmanned and manned testing. Test data should be from a recognized, independent test facility.

e) The following documentation for each rebreather model to be used should be available as a set of manufacturer's specifications. These should include:

- Operational depth range
- Operational temperature range
- Breathing gas mixtures that may be used
- Maximum exercise level which can be supported as a function of breathing gas and depth
- Breathing gas supply durations as a function of exercise level and depth
- CO_2 absorbent durations, as a function of depth, exercise level, breathing gas, and water temperature
- Method, range and precision of inspired PPO_2 control, as a function of depth, exercise level, breathing gas, and temperature
- Likely failure modes and backup or redundant systems designed to protect the diver if such failures occur
- Accuracy and precision of all readouts and sensors
- Battery duration as a function of depth and temperature
- Mean time between failures of each subsystem and method of determination

f) A complete instruction manual is required, fully describing the operation of all rebreather components and subsystems as well as maintenance procedures.

g) A maintenance log is required. The unit maintenance shall be up-to-date based upon manufacturer’s recommendations.

Minimum Equipment

a) A surface/dive valve in the mouthpiece assembly, allowing sealing of the breathing loop from the external environment when not in use.

b) An automatic gas addition valve, so that manual volumetric compensation during descent is unnecessary.

c) Manual gas addition valves, so that manual volumetric compensation during descent and manual oxygen addition at all times during the dive are possible.

d) The diver shall carry alternate life support capability (open-circuit bail-out or redundant rebreather) sufficient to allow the solution of minor problems and allow reliable access to a pre-planned alternate life support system.

Oxygen Rebreathers

Oxygen rebreathers shall be equipped with manual and automatic gas addition valves.

Semi-Closed Circuit Rebreathers.

SCR's shall be equipped with at least one manufacturer-approved oxygen sensor sufficient to warn the diver of impending hypoxia. Sensor redundancy is desirable, but not required.

Closed Circuit Mixed-gas Rebreathers.

a) CCR shall incorporate a minimum of three independent oxygen sensors.

b) A minimum of two independent displays of oxygen sensor readings shall be available to the diver.

c) Two independent power supplies in the rebreather design are desirable. If only one is present, a secondary system to monitor oxygen levels without power from the primary battery must be incorporated.

d) CCR shall be equipped with manual diluent and oxygen addition valves, to enable the diver to maintain safe oxygen levels in the event of failure of the primary power supply or automatic gas addition systems.

e) Redundancies in onboard electronics, power supplies, and life support systems are highly desirable.

12.40 Operational Requirements

General Requirements

a) All dives involving rebreathers must comply with applicable operational requirements for open-circuit SCUBA dives to equivalent depths.

b) No rebreather system should be used in situations beyond the manufacturer's stated design limits (dive depth, duration, water temperature, etc).

c) Modifications to rebreather systems shall be in compliance with manufacturer's recommendations.

d) Rebreather maintenance is to be in compliance with manufacturer's recommendations including sanitizing, replacement of consumables (sensors, CO_2 absorbent, gas, batteries, etc) and periodic maintenance.

e) Dive Plan. In addition to standard dive plan components stipulated in AAUS Section 2.0, all dive plans that include the use of rebreathers must include, at minimum, the following details:

- Information about the specific rebreather model to be used
- Make, model, and type of rebreather system
- Type of CO_2 absorbent material
- Composition and volume(s) of supply gases
- Complete description of alternate bailout procedures to be employed, including manual rebreather operation and open-circuit procedures
- Other specific details as requested by DCB

Buddy Qualifications.

a) A diver whose buddy is diving with a rebreather shall be trained in basic rebreather operation, hazard identification, and assist/rescue procedures for a rebreather diver.

b) If the buddy of a rebreather diver is using open-circuit scuba, the rebreather diver must be equipped with a means to provide the open-circuit scuba diver with a sufficient supply of open-circuit breathing gas to allow both divers to return safely to the surface.

Oxygen Exposures

a) Planned oxygen partial pressure in the breathing gas shall not exceed 1.4 atmospheres at depths greater than 30 feet.

b) Planned oxygen partial pressure set point for CCR shall not exceed 1.4 ata. Set point at depth should be reduced to manage oxygen toxicity according to the NOAA Oxygen Exposure Limits.

c) Oxygen exposures should not exceed the NOAA oxygen single and daily exposure limits. Both CNS and pulmonary (whole-body) oxygen exposure indices should be tracked for each diver.

Decompression Management

a) DCB shall review and approve the method of decompression management selected for a given diving application and project.

b) Decompression management can be safely achieved by a variety of methods, depending on the type and model of rebreather to be used. Following is a general list of methods for different rebreather types:

1. Oxygen rebreathers: Not applicable.

2. SCR (presumed constant FO_2):

   - Use of any method approved for open-circuit scuba diving breathing air, above the maximum operational depth of the supply gas.
   - Use of open-circuit nitrox dive tables based upon expected inspired FO_2. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.
   - Equivalent air depth correction to open-circuit air dive tables, based upon expected inspired FO_2 for planned exertion level, gas supply rate, and gas composition. In this case, contingency air dive tables may be necessary for active-addition SCR's in the event that exertion level is higher than expected.

3. CCR (constant PPO_2):

   - Integrated constant PPO_2 dive computer.
   - Non-integrated constant PPO_2 dive computer.
   - Constant PPO_2 dive tables.
   - Open-circuit (constant FO_2) nitrox dive computer, set to inspired FO_2 predicted using PPO_2 set point at the maximum planned dive depth.
   - Equivalent air depth (EAD) correction to standard open-circuit air dive tables, based on the inspired FO_2 predicted using the PPO_2 set point at the maximum planned dive depth.
   - Air dive computer, or air dive tables used above the maximum operating depth (MOD) of air for the PPO_2 setpoint selected.

Maintenance Logs, $CO2$ Scrubber Logs, Battery Logs, and Pre-And Post-Dive Checklists

Logs and checklists will be developed for the rebreather used, and will be used before and after every dive. Diver shall indicate by initialing that checklists have been completed before and after each dive. Such documents shall be filed and maintained as permanent project records. No rebreather shall be dived which has failed any portion of the pre-dive check, or is found to not be operating in accordance with manufacturer's specifications. Pre-dive checks shall include:

- Gas supply cylinders full
- Composition of all supply and bail-out gases analyzed and documented
- Oxygen sensors calibrated
- Carbon dioxide canister properly packed
- Remaining duration of canister life verified
- Breathing loop assembled
- Positive and negative pressure leak checks
- Automatic volume addition system working
- Automatic oxygen addition systems working
- Pre-breathe system for 3 minutes (5 minutes in cold water) to ensure proper oxygen addition and carbon dioxide removal (be alert for signs of hypoxia or hypercapnia)
- Other procedures specific to the model of rebreather used
- Documentation of ALL components assembled
- Complete pre-dive system check performed
- Final operational verification immediately before to entering the water:
- PO_2 in the rebreather is not hypoxic
- Oxygen addition system is functioning;
- Volumetric addition is functioning
- Bail-out life support is functioning

Alternate Life Support System

The diver shall have reliable access to an alternate life support system designed to safely return the diver to the surface at normal ascent rates, including any required decompression in the event of primary rebreather failure. The complexity and extent of such systems are directly related to the depth/time profiles of the mission. Examples of such systems include, but are not limited to:

a) Open-circuit bailout cylinders or sets of cylinders, either carried or pre-positioned

b) Redundant rebreather

c) Pre-positioned life support equipment with topside support

CO2 Absorbent Material

a) CO_2 absorption canister shall be filled in accordance with the manufacturer's specifications.

b) CO_2 absorbent material shall be used in accordance with the manufacturer's specifications for expected duration.

c) If CO_2 absorbent canister is not exhausted and storage between dives is planned, the canister should be removed from the unit and stored sealed and protected from ambient air, to ensure the absorbent retains its activity for subsequent dives.

d) Long-term storage of carbon dioxide absorbents shall be in a cool, dry location in a sealed container. Field storage must be adequate to maintain viability of material until use.

Consumables (e.g., batteries, oxygen sensors, etc.)

Other consumables (e.g., batteries, oxygen sensors, etc.) shall be maintained, tested, and replaced in accordance with the manufacturer's specifications.

Unit Disinfections

The entire breathing loop, including mouthpiece, hoses, counterlungs, and CO2 canister, should be disinfected periodically according to manufacturer's specifications. The loop must be disinfected between each use of the same rebreather by different divers.

12.50 Oxygen Rebreathers

a) Oxygen rebreathers shall not be used at depths greater than 20 feet.

b) Breathing loop and diver's lungs must be adequately flushed with pure oxygen prior to entering the water on each dive. Once done, the diver must breathe continuously and solely from the intact loop, or re-flushing is required.

c) Breathing loop shall be flushed with fresh oxygen prior to ascending to avoid hypoxia due to inert gas in the loop.

12.60 Semi-Closed Circuit Rebreathers

a) The composition of the injection gas supply of a semi-closed rebreather shall be chosen such that the partial pressure of oxygen in the breathing loop will not drop below 0.2 ata, even at maximum exertion at the surface.

b) The gas addition rate of active addition SCR (e.g., Draeger Dolphin and similar units) shall be checked before every dive, to ensure it is balanced against expected workload and supply gas FO_2.

c) The intermediate pressure of supply gas delivery in active-addition SCR shall be checked periodically, in compliance with manufacturer's recommendations.

d) Maximum operating depth shall be based upon the FO_2 in the active supply cylinder.

e) Prior to ascent to the surface the diver shall flush the breathing loop with fresh gas or switch to an open-circuit system to avoid hypoxia. The flush should be at a depth of approximately 30 fsw during ascent on dives deeper than 30 fsw, and at bottom depth on dives 30 fsw and shallower.

12.70 Closed-Circuit Rebreathers

a) The FO_2 of each diluent gas supply used shall be chosen so that, if breathed directly while in the depth range for which its use is intended, it will produce an inspired PPO_2 greater than 0.20 ata but no greater than 1.4 ata.

b) Maximum operating depth shall be based on the FO_2 of the diluent in use during each phase of the dive, so as not to exceed a PO_2 limit of 1.4 ata.

c) Divers shall monitor both primary and secondary oxygen display systems at regular intervals throughout the dive, to verify that readings are within limits, that redundant displays are providing similar values, and whether readings are dynamic or static (as an indicator of sensor failure).

d) The PPO_2 set point shall not be lower than 0.4 ata or higher than 1.4 ata.

SECTION 13 SCIENTIFIC CAVE AND CAVERN DIVING STANDARD

This standard helps to ensure all scientific diving in overhead environments is conducted in a manner which will maximize the protection of scientific divers from accidental injury and/or illness and provide the basis allowing the working reciprocity between AAUS organizational members.

If a conflict exists between this standard and other standards in this manual, the information set forth in this standard only takes precedence when the scientific diving being conducted takes place wholly or partly within an underwater cave or cavern environment.

A dive team shall be considered to be cave or cavern diving if at any time during the dive they find themselves in a position where they cannot complete a direct, unobstructed ascent to the surface because of rock formations.

The member organization requires that no person shall engage in scientific cave or cavern diving unless that person holds a recognized certificate/authorization issued pursuant to the provisions of this manual.

The diver must demonstrate to the DCB or its designee that the diver possesses the proper attitude, judgment, and discipline to safety conduct cave and cavern diving in the context of planned operations.

Operational requirements for cave and cavern diving have been established through accident analysis of previous cave diving accidents.

13.1 Definitions

Alternate Gas Supply - Fully redundant system capable of providing a gas source to the diver should their primary gas supply fail.

Bubble Check **-** Visual examination by the dive team of their diving systems, looking for o-ring leaks or other air leaks conducted in the water prior to entering a cave. Usually included in the "S" Drill.

Cave – A dive shall be considered a cave dive if any one or more of the environmental limits specified in the definition of cavern are exceeded or otherwise not followed. Linear penetrations limits shall not exceed the limits of each diver's training.

Cave Dive - A dive, which takes place partially or wholly underground, in which one or more of the environmental parameters defining a cavern dive are exceeded.

Cavern - An entrance and first chamber to a cave where:
1. Sunlight from the entrance is visible to all dive team members at all times during the dive.
2. Members of the dive team do not pass through any restrictions that don't allow the divers to swim side by side during the dive, nor are there any restrictions between the divers and the most expeditious exit to the surface.
3. Maximum depth achieved shall not exceed the depth ratings of dive team.

Cavern Dive **-** A dive which takes place partially or wholly underground, in which the following environmental parameters are met:
1. Natural sunlight is continuously visible from the entrance.
2. Environmental conditions will be evaluated by the DSO or designee and appropriate limits incorporated into the dive plan.

Dual Valve Manifold with Isolator Valve - A manifold joining two diving cylinders, that allows the use of two completely independent regulators. If either regulator fails, it may be shut off, allowing the remaining regulator access to the gas in both of the diving cylinders.

Gas Management - Gas planning rule which is used in cave diving environments in which the diver reserves a portion of their available breathing gas for anticipated emergencies (See Rule of Thirds, Sixths).

Guideline - Continuous line used as a navigational reference during a dive leading from the team position to a point where a direct vertical ascent may be made to the surface.

Jump/Gap Reel -Spool or reel used to connect one guide line to another thus ensuring a continuous line to the exit.

Knife/Line Cutter - Small, sharp blade capable of easily cutting a guideline and that is accessible to the diver.

Lava Tube - Type of cave or cavern formed by the surface hardening of a stream of flowing molten rock, which may later become flooded due to static sea level changes.

Line Marker - Any one of several types of markers attached to a guideline, which provides additional navigational information to the dive team, most commonly the direction out to the nearest surface.

Mine Diving - Diving in the flooded portions of a man-made mine. Necessitates use of techniques detailed for cave diving.

Penetration Distance - Linear distance from the entrance intended or reached by a dive team during a dive at a dive site.

Primary Reel - Initial guideline used by the dive team from open water to maximum penetration or a permanently installed guideline.

Restriction - Any passage through which two divers cannot easily pass side by side while sharing air.

Rule of Thirds - Gas planning rule which is used in cave diving environments in which the diver reserves 2/3's of their breathing gas supply for exiting the cave or cavern.

Rule of Sixths - Air planning rule which is used in cave or other confined diving environments in which the diver reserves 5/6's of their breathing gas supply (for DPV use, siphon diving, etc.) for exiting the cave or cavern.

Safety Drill - ("S" Drill) - Short gas sharing, equipment evaluation, dive plan, and communication exercise carried out prior to entering a cave or cavern dive by the dive team.

Safety Reel - Secondary reel used as a backup to the primary reel, usually containing 150 feet of guideline that is used in an emergency.

Scientific Cave or Cavern Diver In Training - Authorized to dive in the cave or cavern environment under the direct supervision of qualified instructional personnel for training purposes only.

Scientific Cavern Diver - Authorization to dive in an overhead environment as defined in cavern.

Scientific Cave Diver - Authorization to dive in an overhead environment as defined in cave.

Sidemount Diving - A diving mode utilizing two independent SCUBA systems carried along the sides of the diver's body; either of which always has sufficient air to allow the diver to reach the surface unassisted.

Siphon - Cave into which water flows with a generally continuous in-current.

Solution Cave - Cave formed in carbonate or carbonate-cemented bedrock, formed by the dissolution of the rock by groundwater.

Spring - Cave with water flowing with a generally continuous outflow.

Sump - An area in a dry cave that can no longer be negotiated without the use of diving equipment.

Well - A vertical or nearly vertical shaft, usually manmade, through which a diver can access a dive site.

13.2 Cave and Cavern Environment Hazards

Current/Flow - Underwater caves have currents that vary in strength and direction. Of particular note is a condition known as siphoning. Siphoning caves have flow or current directed into the cave. This can cause poor visibility as a result of mud and silt being drawn into the cave entrance.

Silt - The presences of silt, sand, mud, clay, etc. on the cave floor can cause visibility to be reduced to nothing in a very short time.

Restrictions - Any passage through which two divers cannot easily pass side by side while sharing air make air sharing difficult.

Cave-ins - Cave-ins are a normal part of cave evolution; however experiencing a cave-in during diving operations is extremely unlikely.

13.3 Minimum Experience and Training Requirements

a) Cavern Diver

1. Prerequisites

   The applicant for training shall have met the requirements in Section 5.00 of the AAUS *Standards for Scientific Diving Certification and Operation of Scientific Diving Programs*, fourth edition (2003), and hold as a minimum a scientific diver permit.

2. Cavern Training

   The applicant is to participate in the following areas of training, or their equivalent:

   - Classroom Lecture and Critique—The applicant shall participate in classroom discussion or equivalent type activities covering these topics: Policy for cavern diving, cavern environment and environmental hazards, accident analysis, psychological considerations, equipment, body control, communications, cavern diving techniques, navigation and guidelines, dive planning, cave geology, cave hydrology, cave biology, and emergency procedures.
   - Land Drills—The applicant shall participate in drills above water using the guideline and reel. Drills are to emphasize proper use of the reel, techniques and considerations for laying a guideline, guideline following, buddy communication, and emergency procedures.

- Cavern Dives—A minimum of four (4) cavern dives, preferably to be conducted in a minimum of two (2) different caverns. Skills the applicant should demonstrate include: Safety drill (S-drill), gear matching, bubble check prior to entering the cavern on each dive, proper buoyancy compensator use, proper trim and body positioning, hovering and buoyancy with hand tasks, specialized propulsion techniques (modified flutter kick, modified frog kick, pull and glide, ceiling walk or shuffle), proper guideline and reel use, ability to follow the guideline with no visibility, sharing air while following a guideline, and sharing air while following the guideline with no visibility light and hand signal use, and ability to comfortably work in a cavern without assistance.
- Written Examination - A written evaluation approved by the DCB with a predetermined passing score, covering concepts of both classroom and practical training is required.

b) Cave Diver

1. Prerequisites

The applicant for training shall hold as a minimum a cavern diver permit.

2. Cave Training

The applicant is to participate in the following areas of training, or their equivalent:

Classroom Lecture and Critique—The applicant shall participate in classroom discussion or equivalent type activities covering these topics: Review of the topics listed in cavern diver training and differing techniques and procedures used in cave diving, additional equipment procedures used in cave diving, cave diving equipment configurations, procedures for conducting diving operations involving complex navigation and use of line markers, advanced gas management and a thorough review of dive tables, decompression tables, and decompression theory.

- Land Drills—The applicant shall participate in drills above water included in cavern training. Drills are to emphasize proper use of the reel in lost diver procedures, as well as line placements and station location as required for surveying.
- Cave Dives—A minimum of twelve (12) cave dives, to be conducted in a minimum of four (4) different cave sites with differing conditions recommended. Skills the applicant should demonstrate include: Review of skills listed in cavern training, and special techniques in buoyancy control, referencing and back-up navigation, air sharing in a minor restriction using a single file method, special propulsion techniques in heavy outflow, anti-silting techniques, line jumping techniques and protocols, surveying, and ability to critique their dives. Emergency procedures training shall include proficiency in lost line, lost diver, gas sharing, light failure, valve manipulation, and no/low visibility situations.
- Written Examination - A written evaluation approved by the DCB with a predetermined passing score, covering concepts of both classroom and practical training is required.

13.4 Equipment Requirements

Equipment used for SCUBA in cave or cavern diving is based on the concept of redundancy. Redundant SCUBA equipment shall be carried whenever the planned penetration distances are such that an emergency swimming ascent is not theoretically possible.

a) Cavern Diving Equipment

The following equipment shall be required, in excess of that detailed for open water SCUBA diving in Volume 1, Section 3.00. Each member of the dive team shall have:

- At minimum, a single tank equipped with an “H” valve or an alternate air supply.
- A BCD capable of being inflated from the tank.
- Slate and pencil.
- Two battery powered secondary lights of an approved type.
- Knife or line cutter.
- One primary reel of at least 350 feet for each team.
- Snorkel—No snorkel shall be worn while inside underwater cave or cavern.

b) Cave Diving Equipment

The following equipment shall be required, in excess of that detailed for cavern diving: Each member of the dive team shall have:

- Cylinders with dual orifice isolation valve manifold or independent SCUBA systems each capable of maintaining enough gas for the diver during exit and ascent to the surface.
- Two completely independent regulators, at least one of each having submersible tank pressure gauge, a five foot or longer second stage hose, low pressure inflator for the BCD.
- A primary light with sufficient burn time for the planned dive.
- Safety reel with at least 150 feet of line.
- Appropriate submersible dive tables and/or dive computer (computers w/ backup tables).
- Line markers.
- Snorkel—No snorkel shall be worn while inside underwater cave or cavern.

13.5 Operational Requirements and Safety Protocols

All members of the dive team must have met the applicable all sections of Volume One and applicable sections of Volume Two of the AAUS manual and be authorized for that type of diving by the DCB before conducting scientific cave dives.

a) Cavern Diver Procedures

- Cavern diving shall not be conducted at depths greater than 100 feet.
- Dive teams shall perform a safety drill prior to each cave or cavern penetration that includes equipment check, gas management, and dive objectives.
- Each team within the cavern zone must utilize a continuous guideline appropriate for the environment leading to a point from which an uninterrupted ascent to the surface may be made.
- Gas management must be appropriate for the planned dive with special considerations made for; DPV's, siphon diving, rebreathers, etc.
- The entire dive team is to immediately terminate the dive whenever any dive team member feels an unsafe condition is present.

b) Cave Diving Procedures

- Dive teams shall perform a safety drill prior to each cave or cavern penetration that includes equipment check, gas management, and dive objectives.
- Diver teams must run or follow a continuous guideline from the surface pool to maximum penetration.
- Gas management must be appropriate for the planned dive with special considerations made for: DPV's, siphon diving, rebreathers, etc.
- Each diver must carry one primary and two back up lights.
- Divers utilizing side mount diving or other dual independent diving systems must have the approval of the Diving Safety Officer or his/her designee.
- The entire dive team is to immediately terminate the dive whenever any dive team member feels an unsafe condition is present.

Appendices

Appendix 1 through 9
Required For All Organizational Members

APPENDIX 1
DIVING MEDICAL EXAM OVERVIEW FOR THE EXAMINING PHYSICIAN

TO THE EXAMINING PHYSICIAN:

This person, ______________________, requires a medical examination to assess their fitness for certification as a Scientific Diver for the________________________ (Organizational Member). Their answers on the Diving Medical History Form (attached) may indicate potential health or safety risks as noted. Your evaluation is requested on the attached scuba Diving Fitness Medical Evaluation Report. If you have questions about diving medicine, you may wish to consult one of the references on the attached list or contact one of the physicians with expertise in diving medicine whose names and phone numbers appear on an attached list, the Undersea Hyperbaric and Medical Society, or the Divers Alert Network. Please contact the undersigned Diving Safety Officer if you have any questions or concerns about diving medicine or the ___________________________ standards. Thank you for your assistance.
Organizational Member

____ ______________________________
Diving Safety Officer Date

____ ______________________________
Printed Name Phone Number

Scuba and other modes of compressed-gas diving can be strenuous and hazardous. A special risk is present if the middle ear, sinuses, or lung segments do not readily equalize air pressure changes. The most common cause of distress is eustachian insufficiency. Recent deaths in the scientific diving community have been attributed to cardiovascular disease. Please consult the following list of conditions that usually restrict candidates from diving.
(Adapted from Bove, 1998: bracketed numbers are pages in Bove)

CONDITIONS WHICH MAY DISQUALIFY CANDIDATES FROM DIVING

1. Abnormalities of the tympanic membrane, such as perforation, presence of a monomeric membrane, or inability to autoinflate the middle ears. [5 ,7, 8, 9]
2. Vertigo, including Meniere's Disease. [13]
3. Stapedectomy or middle ear reconstructive surgery. [11]
4. Recent ocular surgery. [15, 18, 19]
5. Psychiatric disorders including claustrophobia, suicidal ideation, psychosis, anxiety states, untreated depression. [20 - 23]
6. Substance abuse, including alcohol. [24 - 25]
7. Episodic loss of consciousness. [1, 26, 27]
8. History of seizure. [27, 28]
9. History of stroke or a fixed neurological deficit. [29, 30]
10. Recurring neurologic disorders, including transient ischemic attacks. [29, 30]
11. History of intracranial aneurysm, other vascular malformation or intracranial hemorrhage. [31]
12. History of neurological decompression illness with residual deficit. [29, 30]
13. Head injury with sequelae. [26, 27]
14. Hematologic disorders including coagulopathies. [41, 42]
15. Evidence of coronary artery disease or high risk for coronary artery disease. [33 - 35]
16. Atrial septal defects. [39]
17. Significant valvular heart disease - isolated mitral valve prolapse is not disqualifying. [38]
18. Significant cardiac rhythm or conduction abnormalities. [36 - 37]
19. Implanted cardiac pacemakers and cardiac defibrillators (ICD). [39, 40]
20. Inadequate exercise tolerance. [34]
21. Severe hypertension. [35]
22. History of spontaneous or traumatic pneumothorax. [45]
23. Asthma. [42 - 44]
24. Chronic pulmonary disease, including radiographic evidence of pulmonary blebs, bullae, or cysts. [45,46]
25. Diabetes mellitus. [46 - 47]
26. Pregnancy. [56]

SELECTED REFERENCES IN DIVING MEDICINE
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- NOAA DIVING MANUAL, NOAA. Superintendent of Documents. Washington, DC: U.S. Government Printing Office.
- U.S. NAVY DIVING MANUAL. Superintendent of Documents, Washington, DC: U.S. Government Printing Office, Washington, D.C.

APPENDIX 2
AAUS MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT

____ ________________________________
Name of Applicant (Print or Type) Date of Medical Evaluation (Month/Day/Year)

To The Examining Physician: Scientific divers require periodic scuba diving medical examinations to assess their fitness to engage in diving with self-contained underwater breathing apparatus (scuba). Their answers on the Diving Medical History Form may indicate potential health or safety risks as noted. Scuba diving is an activity that puts unusual stress on the individual in several ways. Your evaluation is requested on this Medical Evaluation form. Your opinion on the applicant's medical fitness is requested. Scuba diving requires heavy exertion. The diver must be free of cardiovascular and respiratory disease (see references, following page). An absolute requirement is the ability of the lungs, middle ears and sinuses to equalize pressure. Any condition that risks the loss of consciousness should disqualify the applicant. Please proceed in accordance with the AAUS Medical Standards (Sec. 6.00). If you have questions about diving medicine, please consult with the Undersea Hyperbaric Medical Society or Divers Alert Network.

TESTS: THE FOLLOWING TESTS ARE REQUIRED:

DURING ALL INITIAL AND PERIODIC RE-EXAMS (UNDER AGE 40):

- Medical history
- Complete physical exam, with emphasis on neurological and otological components
- Urinalysis
- Any further tests deemed necessary by the physician

ADDITIONAL TESTS DURING FIRST EXAM OVER AGE 40 AND PERIODIC RE-EXAMS (OVER AGE 40):

- Chest x-ray (Required only during first exam over age 40)
- Resting EKG
- Assessment of coronary artery disease using Multiple-Risk-Factor Assessment[1]
  (age, lipid profile, blood pressure, diabetic screening, smoking)
  Note: Exercise stress testing may be indicated based on Multiple-Risk-Factor Assessment[2]

PHYSICIAN'S STATEMENT:

_______ 01 Diver **IS** medically qualified to dive for: ______________2 years (over age 60)
______________3 years (age 40-59)
______________5 years (under age 40)

_______ 02 Diver **IS NOT** medically qualified to dive:____________Permanently_______Temporarily.

I have evaluated the abovementioned individual according to the American Academy of Underwater Sciences medical standards and required tests for scientific diving (Sec. 6.00 and Appendix 1) and, in my opinion, find no medical conditions that may be disqualifying for participation in scuba diving. I have discussed with the patient any medical condition(s) that would not disqualify him/her from diving but which may seriously compromise subsequent health. The patient understands the nature of the hazards and the risks involved in diving with these conditions.

____ MD or DO __________________________
Signature Date

____
Name (Print or Type)

____
Address

_____________________________ ____
Telephone Number E-Mail Address

My familiarity with applicant is: _____This exam only _____Regular physician for _______ years

My familiarity with diving medicine is: ____

APPENDIX 2b
AAUS MEDICAL EVALUATION OF FITNESS FOR SCUBA DIVING REPORT

APPLICANT'S RELEASE OF MEDICAL INFORMATION FORM

____

Name of Applicant (Print or Type)

I authorize the release of this information and all medical information subsequently acquired in association with my diving to the ______________________________ Diving Safety Officer and Diving Control Board or their designee at (place) __________________________________ on (date) ________________________

Signature of Applicant ____ Date_________________

REFERENCES

[1] Grundy, S.M., Pasternak, R., Greenland, P., Smith, S., and Fuster, V. 1999. Assessment of Cardiovascular Risk by Use of Multiple-Risk-Factor Assessment Equations. AHA/ACC Scientific Statement. *Journal of the American College of Cardiology*, 34: 1348-1359. http://content.onlinejacc.org/cgi/content/short/34/4/1348

APPENDIX 3
DIVING MEDICAL HISTORY FORM

(To Be Completed By Applicant-Diver)

Name ______________________________________ Sex ____ Age ___ Wt.___ Ht. ___

Sponsor ____ Date ___/___/___
(Dept./Project/Program/School, etc.) (Mo/Day/Yr)

TO THE APPLICANT:

Scuba diving places considerable physical and mental demands on the diver. Certain medical and physical requirements must be met before beginning a diving or training program. Your accurate answers to the questions are more important, in many instances, in determining your fitness to dive than what the physician may see, hear or feel as part of the diving medical certification procedure.

This form shall be kept confidential by the examining physician. If you believe any question amounts to invasion of your privacy, you may elect to omit an answer, provided that you shall subsequently discuss that matter with your own physician who must then indicate, in writing, that you have done so and that no health hazard exists.

Should your answers indicate a condition, which might make diving hazardous, you will be asked to review the matter with your physician. In such instances, their written authorization will be required in order for further consideration to be given to your application. If your physician concludes that diving would involve undue risk for you, remember that they are concerned only with your well-being and safety.

	Yes	**No**	**Please indicate whether or not the following apply to you**	**Comments**
1			Convulsions, seizures, or epilepsy	
2			Fainting spells or dizziness	
3			Been addicted to drugs	
4			Diabetes	
5			Motion sickness or sea/air sickness	
6			Claustrophobia	
7			Mental disorder or nervous breakdown	
8			Are you pregnant?	
9			Do you suffer from menstrual problems?	
10			Anxiety spells or hyperventilation	
11			Frequent sour stomachs, nervous stomachs or vomiting spells	
12			Had a major operation	
13			Presently being treated by a physician	
14			Taking any medication regularly (even non-prescription)	
15			Been rejected or restricted from sports	
16			Headaches (frequent and severe)	
17			Wear dental plates	

	Yes	No	Please indicate whether or not the following apply to you	Comments
18			Wear glasses or contact lenses	
19			Bleeding disorders	
20			Alcoholism	
21			Any problems related to diving	
22			Nervous tension or emotional problems	
23			Take tranquilizers	
24			Perforated ear drums	
25			Hay fever	
26			Frequent sinus trouble, frequent drainage from the nose, post-nasal drip, or stuffy nose	
27			Frequent earaches	
28			Drainage from the ears	
29			Difficulty with your ears in airplanes or on mountains	
30			Ear surgery	
31			Ringing in your ears	
32			Frequent dizzy spells	
33			Hearing problems	
34			Trouble equalizing pressure in your ears	
35			Asthma	
36			Wheezing attacks	
37			Cough (chronic or recurrent)	
38			Frequently raise sputum	
39			Pleurisy	
40			Collapsed lung (pneumothorax)	
41			Lung cysts	
42			Pneumonia	
43			Tuberculosis	

	Yes	No	Please indicate whether or not the following apply to you	Comments
44			Shortness of breath	
45			Lung problem or abnormality	
46			Spit blood	
47			Breathing difficulty after eating particular foods, after exposure to particular pollens or animals	
48			Are you subject to bronchitis	
49			Subcutaneous emphysema (air under the skin)	
50			Air embolism after diving	
51			Decompression sickness	
52			Rheumatic fever	
53			Scarlet fever	
54			Heart murmur	
55			Large heart	
56			High blood pressure	
57			Angina (heart pains or pressure in the chest)	
58			Heart attack	
59			Low blood pressure	
60			Recurrent or persistent swelling of the legs	
61			Pounding, rapid heartbeat or palpitations	
62			Easily fatigued or short of breath	
63			Abnormal EKG	
64			Joint problems, dislocations or arthritis	
65			Back trouble or back injuries	
66			Ruptured or slipped disk	
67			Limiting physical handicaps	
68			Muscle cramps	
69			Varicose veins	

	Yes	No	Please indicate whether or not the following apply to you	Comments
70			Amputations	
71			Head injury causing unconsciousness	
72			Paralysis	
73			Have you ever had an adverse reaction to medication?	
74			Do you smoke?	
75			Have you ever had any other medical problems not listed? If so, please list or describe below;	
76			Is there a family history of high cholesterol?	
77			Is there a family history of heart disease or stroke?	
78			Is there a family history of diabetes?	
79			Is there a family history of asthma?	
80			Date of last tetanus shot? Vaccination dates?	

Please explain any "yes" answers to the above questions.

I certify that the above answers and information represent an accurate and complete description of my medical history.

Signature Date

APPENDIX 4
RECOMMENDED PHYSICIANS WITH EXPERTISE IN DIVING MEDICINE

List of local Medical Doctors that have training and expertise in diving or undersea medicine. Level I graduates of the Undersea Hyperbaric and Medical Society (UHMS) Fitness to Dive courses (approximately 250 physicians) are listed at http://membership.uhms.org/?page=DivingMedical (UHMS website, go to Resources, go to Library, go to Diving Medical Examiners)

1. Name:________________________________
   Address:________________________________
   ____
   Telephone: ________________________________
2. Name:________________________________
   Address:________________________________
   ____
   Telephone: ________________________________
3. Name:________________________________
   Address:________________________________
   ____
   Telephone: ________________________________
4. Name:________________________________
   Address:________________________________
   ____
   Telephone: ________________________________
5. Name:________________________________
   Address:________________________________
   ____
   Telephone: ________________________________

APPENDIX 5
DEFINITION OF TERMS

Air sharing - Sharing of an air supply between divers.

ATA(s) - “Atmospheres Absolute”, Total pressure exerted on an object, by a gas or mixture of gases, at a specific depth or elevation, including normal atmospheric pressure.

Breath-hold Diving - A diving mode in which the diver uses no self-contained or surface-supplied air or oxygen supply.

Buddy Breathing - Sharing of a single air source between divers.

Buddy Diver - Second member of the dive team.

Buddy System -Two comparably equipped scuba divers in the water in constant communication.

Buoyant Ascent - An ascent made using some form of positive buoyancy.

Burst Pressure - Pressure at which a pressure containment device would fail structurally.

Certified Diver - A diver who holds a recognized valid certification from an organizational member or internationally recognized certifying agency.

Controlled Ascent - Any one of several kinds of ascents including normal, swimming, and air sharing ascents where the diver(s) maintain control so a pause or stop can be made during the ascent.

Cylinder - A pressure vessel for the storage of gases.

Decompression Chamber - A pressure vessel for human occupancy. Also called a hyperbaric chamber or decompression chamber.

Decompression Sickness - A condition with a variety of symptoms, which may result from gas, and bubbles in the tissues of divers after pressure reduction.

Dive - A descent into the water, an underwater diving activity utilizing compressed gas, an ascent, and return to the surface.

Dive Computer- A microprocessor based device which computes a diver’s theoretical decompression status, in real time, by using pressure (depth) and time as input to a decompression model, or set of decompression tables, programmed into the device.

Dive Location - A surface or vessel from which a diving operation is conducted.

Dive Site - Physical location of a diver during a dive.

Dive Table - A profile or set of profiles of depth-time relationships for ascent rates and breathing mixtures to be followed after a specific depth-time exposure or exposures.

Diver - An individual in the water who uses apparatus, including snorkel, which supplies breathing gas at ambient pressure.

Diver-In-Training - An individual gaining experience and training in additional diving activities under the supervision of a dive team member experienced in those activities.

Diver-Carried Reserve Breathing Gas - A diver-carried independent supply of air or mixed gas (as appropriate) sufficient under standard operating conditions to allow the diver to reach the surface, or another source of breathing gas, or to be reached by another diver.

Diving Mode - A type of diving required specific equipment, procedures, and techniques, for example, snorkel, scuba, surface-supplied air, or mixed gas.

Diving Control Board (DCB) - Group of individuals who act as the official representative of the membership organization in matters concerning the scientific diving program (Section 1.24).

Diving Safety Officer (DSO) - Individual responsible for the safe conduct of the scientific diving program of the membership organization (Section 1.20).

EAD - Equivalent Air Depth (see below).

Emergency Ascent - An ascent made under emergency conditions where the diver exceeds the normal ascent rate.

Enriched Air (EANx) - A name for a breathing mixture of air and oxygen when the percent of oxygen exceeds 21%. This term is considered synonymous with the term “nitrox” (Section 7.00).

Equivalent Air Depth (EAD) - Depth at which air will have the same nitrogen partial pressure as the nitrox mixture being used. This number, expressed in units of feet seawater or saltwater, will always be less than the actual depth for any enriched air mixture.

fN_2 - Fraction of nitrogen in a gas mixture, expressed as either a decimal or percentage, by volume.

fO_2 - Fraction of oxygen in a gas mixture, expressed as either a decimal or percentage, by volume.

FFW – Feet or freshwater, or equivalent static head.

FSW - Feet of seawater, or equivalent static head.

Hookah - While similar to Surface Supplied in that the breathing gas is supplied from the surface by means of a pressurized hose, the supply hose does not require a strength member, pneumofathometer hose, or communication line. Hookah equipment may be as simple as a long hose attached to a standard scuba cylinder supplying a standard scuba second stage. The diver is responsible for the monitoring his/her own depth, time, and diving profile.

Hyperbaric Chamber - See decompression chamber.

Hyperbaric Conditions - Pressure conditions in excess of normal atmospheric pressure at the dive location.

Lead Diver - Certified scientific diver with experience and training to conduct the diving operation.

Maximum Working Pressure - Maximum pressure to which a pressure vessel may be exposed under standard operating conditions.

Organizational Member - An organization which is a current member of the AAUS, and which has a program, which adheres to the standards of the AAUS as, set forth in the AAUS Standards for Scientific Diving Certification and Operation of Scientific Diving Programs.

Mixed Gas - MG

Mixed-Gas Diving - A diving mode in which the diver is supplied in the water with a breathing gas other than air.

MOD - Maximum Operating Depth, usually determined as the depth at which the pO_2 for a given gas mixture reaches a predetermined maximum.

MSW - Meters of seawater or equivalent static head.

Nitrox - Any gas mixture comprised predominately of nitrogen and oxygen, most frequently containing between 21% and 40% oxygen. Also be referred to as Enriched Air Nitrox, abbreviated EAN.

NOAA Diving Manual: Refers to the *NOAA Diving Manual, Diving for Science and Technology*, 2001 edition. National Oceanic and Atmospheric Administration, Office of Undersea Research, US Department of Commerce.

No-Decompression limits - Depth-time limits of the “no-decompression limits and repetitive dive group designations table for no-decompression air dives” of the U.S. Navy Diving Manual or equivalent limits.

Normal Ascent - An ascent made with an adequate air supply at a rate of 60 feet per minute or less.

Oxygen Clean - All combustible contaminants have been removed.

Oxygen Compatible - A gas delivery system that has components (o-rings, valve seats, diaphragms, etc.) that are compatible with oxygen at a stated pressure and temperature.

Oxygen Service - A gas delivery system that is both oxygen clean and oxygen compatible.

Oxygen Toxicity Unit - OTU

Oxygen Toxicity - Any adverse reaction of the central nervous system (“acute” or “CNS” oxygen toxicity) or lungs (“chronic”, “whole-body”, or “pulmonary” oxygen toxicity) brought on by exposure to an increased (above atmospheric levels) partial pressure of oxygen.

Pressure-Related Injury - An injury resulting from pressure disequilibrium within the body as the result of hyperbaric exposure. Examples include: decompression sickness, pneumothorax, mediastinal emphysema, air embolism, subcutaneous emphysema, or ruptured eardrum.

Pressure Vessel - See cylinder.

pN_2 - Inspired partial pressure of nitrogen, usually expressed in units of atmospheres absolute.

pO_2 - Inspired partial pressure of oxygen, usually expressed in units of atmospheres absolute.

Psi - Unit of pressure, “pounds per square inch.

Psig - Unit of pressure, “pounds per square inch gauge.

Recompression Chamber - see decompression chamber.

Scientific Diving - Scientific diving is defined (29CFR1910.402) as diving performed solely as a necessary part of a scientific, research, or educational activity by employees whose sole purpose for diving is to perform scientific research tasks.

Scuba Diving - A diving mode independent of surface supply in which the diver uses open circuit self-contained underwater breathing apparatus.

Standby Diver - A diver at the dive location capable of rendering assistance to a diver in the water.

Surface Supplied Diving - Surface Supplied: Dives where the breathing gas is supplied from the surface by means of a pressurized umbilical hose. The umbilical generally consists of a gas supply hose, strength member, pneumofathometer hose, and communication line. The umbilical supplies a helmet or full-face mask. The diver may rely on the tender at the surface to keep up with the divers’ depth, time and diving profile.

Swimming Ascent - An ascent, which can be done under normal or emergency conditions accomplished by simply swimming to the surface.

Umbilical - Composite hose bundle between a dive location and a diver or bell, or between a diver and a bell, which supplies a diver or bell with breathing gas, communications, power, or heat, as appropriate to the diving mode or conditions, and includes a safety line between the diver and the dive location.

Working Pressure - Normal pressure at which the system is designed to operate.

APPENDIX 6

AAUS REQUEST FOR DIVING RECIPROCITY FORM
VERIFICATION OF DIVER TRAINING AND EXPERIENCE

Diver:______________________________ Date:______________

This letter serves to verify that the above listed person has met the training and pre-requisites as indicated below, and has completed all requirements necessary to be certified as a *(Scientific Diver / Diver in Training)* as established by the *(Organizational Member)* Diving Safety Manual, and has demonstrated competency in the indicated areas. (Organizational Member*)* is an AAUS OM and meets or exceeds all AAUS training requirements.

The following is a brief summary of this diver's personnel file regarding dive status at

____
(Date)
________ Original diving authorization
________ Written scientific diving examination
________ Last diving medical examination Medical examination expiration date______________
________ Most recent checkout dive
________ Scuba regulator/equipment service/test
________ CPR training (Agency) __________________ CPR Exp. ________________
________ Oxygen administration (Agency) __________________ 02 Exp. __________________
________ First aid for diving __________________ F.A. Exp. ________________
________ Date of last dive _________ Depth
Number of dives completed within previous 12 months?______ Depth Certification________ fsw
Total number of career dives? _________

Any restrictions? (Y/N)______ if yes, explain:

Please indicate any pertinent specialty certifications or training:

Emergency Information:
Name: Relationship:
Telephone: (work) (home)
Address:

This is to verify that the above individual is currently a certified scientific diver at ________________

Diving Safety Officer:

____ ____________________
(Signature) (Date)

____ __________________________________
(Print)

APPENDIX 7
DIVING EMERGENCY MANAGEMENT PROCEDURES

Introduction
A diving accident victim could be any person who has been breathing air underwater regardless of depth. It is essential that emergency procedures are pre-planned and that medical treatment is initiated as soon as possible. It is the responsibility of each AAUS organizational member to develop procedures for diving emergencies including evacuation and medical treatment for each dive location.

General Procedures
Depending on and according to the nature of the diving accident:

1. Make appropriate contact with victim or rescue as required.
2. Establish (A)irway, (B)reathing, (C)irculation as required.
3. Stabilize the victim
3. Administer 100% oxygen, if appropriate (in cases of Decompression Illness, or Near Drowning).
4. Call local Emergency Medical System (EMS) for transport to nearest medical treatment facility. Explain the circumstances of the dive incident to the evacuation teams, medics and physicians. Do not assume that they understand why 100% oxygen may be required for the diving accident victim or that recompression treatment may be necessary.
5. Call appropriate Diving Accident Coordinator for contact with diving physician and decompression chamber. etc.
6. Notify DSO or designee according to the Emergency Action Plan of the organizational member.
7. Complete and submit Incident Report Form (www.aaus.org) to the DCB of the organization and the AAUS (Section 2.70 Required Incident Reporting).

List of Emergency Contact Numbers Appropriate For Dive Location

____
____
____
____
____
____
____
____
____
____

Available Procedures

- Emergency care
- Recompression
- Evacuation

Emergency Plan Content

- Name, telephone number, and relationship of person to be contacted for each diver in the event of an emergency.
- Nearest operational decompression chamber.
- Nearest accessible hospital.
- Available means of transport.

APPENDIX 8
DIVE COMPUTER GUIDELINES

1. Only those makes and models of dive computers specifically approved by the Diving Control Board may be used.

2. Any diver desiring the approval to use a dive computer as a means of determining decompression status must apply to the Diving Control Board, complete an appropriate practical training session and pass a written examination.

3. Each diver relying on a dive computer to plan dives and indicate or determine decompression status must have his/her own unit.

4. On any given dive, both divers in the buddy pair must follow the most conservative dive computer.

5. If the dive computer fails at any time during the dive, the dive must be terminated and appropriate surfacing procedures should be initiated immediately.

6. A diver should not dive for 18 hours before activating a dive computer to use it to control their diving.

7. Once the dive computer is in use, it must not be switched off until it indicates complete out gassing has occurred or 18 hours have elapsed, whichever comes-first.

8. When using a dive computer, non emergency ascents are to be at a rate specified for the make and model of dive computer being used.

10. Whenever practical, divers using a dive computer should make a stop between 10 and 30 feet for 5 minutes, especially for dives below 60 fsw.

11. Multiple deep dives require special consideration.

APPENDIX 9
AAUS STATISTICS COLLECTION CRITERIA AND DEFINITIONS

COLLECTION CRITERIA:

The "Dive Time in Minutes", The Number of Dives Logged", and the "Number of Divers Logging Dives" will be collected for the following categories.

- Dive Classification
- Breathing Gas
- Diving Mode
- Decompression Planning and Calculation Method
- Depth Ranges
- Specialized Environments
- Incident Types

Dive Time in Minutes is defined as the surface to surface time including any safety or required decompression stops.

A Dive is defined as a descent into water, an underwater diving activity utilizing compressed gas, an ascent/return to the surface, and a surface interval of greater than 10 minutes.

Dives will not be differentiated as openwater or confined water dives. But openwater and confined water dives will be logged and submitted for AAUS statistics classified as either scientific or training/proficiency.

A "Diver Logging a Dive" is defined as a person who is diving under the auspices of your scientific diving organization. Dives logged by divers from another AAUS Organization will be reported with the divers home organization. Only a diver who has actually logged a dive during the reporting period is counted under this category.

Incident(s) occurring during the collection cycle. Only incidents occurring during, or resulting from, a dive where the diver is breathing a compressed gas will be submitted to AAUS.

DEFINITIONS:

Dive Classification:

- Scientific Dives: Dives that meet the scientific diving exemption as defined in 29 CFR 1910.402. Diving tasks traditionally associated with a specific scientific discipline are considered a scientific dive. Construction and trouble-shooting tasks traditionally associated with commercial diving are not considered a scientific dive.
- Training and Proficiency Dives: Dives performed as part of a scientific diver training program, or dives performed in maintenance of a scientific diving certification/authorization.

Breathing Gas:

- Air: Dives where the bottom gas used for the dive is air.
- Nitrox: Dives where the bottom gas used for the dive is a combination of nitrogen and oxygen other than air.
- Mixed Gas: Dives where the bottom gas used for the dive is a combination of oxygen, nitrogen, and helium (or other "exotic" gas), or any other breathing gas combination not classified as air or nitrox.

Diving Mode:

- Open Circuit Scuba: Dives where the breathing gas is inhaled from a self contained underwater breathing apparatus and all of the exhaled gas leaves the breathing loop.
- Surface Supplied: Dives where the breathing gas is supplied from the surface by means of a pressurized umbilical hose. The umbilical generally consists of a gas supply hose, strength member, pneumofathometer hose, and communication line. The umbilical supplies a helmet or full-face mask. The diver may rely on the tender at the surface to keep up with the divers' depth, time and diving profile.
- Hookah: While similar to Surface Supplied in that the breathing gas is supplied from the surface by means of a pressurized hose, the supply hose does not require a strength member, pneumofathometer hose, or communication line. Hookah equipment may be as simple as a long hose attached to a standard scuba cylinder supplying a standard scuba second stage. The diver is responsible for the monitoring his/her own depth, time, and diving profile.
- Rebreathers: Dives where the breathing gas is repeatedly recycled in the breathing loop. The breathing loop may be fully closed or semi-closed. Note: A rebreather dive ending in an open circuit bailout is still logged as a rebreather dive.

Decompression Planning and Calculation Method:

- Dive Tables
- Dive Computer
- PC Based Decompression Software

Depth Ranges:

Depth ranges for sorting logged dives are 0-30, 31-60, 61-100, 101-130, 131-150, 151-190, and 191->. Depths are in feet seawater. A dive is logged to the maximum depth reached during the dive. Note: Only "The Number of Dives Logged" and "The Number of Divers Logging Dives" will be collected for this category.

Specialized Environments:

- Required Decompression: Any dive where the diver exceeds the no-decompression limit of the decompression planning method being employed.
- Overhead Environments: Any dive where the diver does not have direct access to the surface due to a physical obstruction.
- Blue Water Diving: Openwater diving where the bottom is generally greater than 200 feet deep and requiring the use of multiple-tethered diving techniques.
- Ice and Polar Diving: Any dive conducted under ice or in polar conditions. Note: An Ice Dive would also be classified as an Overhead Environment dive.
- Saturation Diving: Excursion dives conducted as part of a saturation mission are to be logged by "classification", "mode", "gas", etc. The "surface" for these excursions is defined as leaving and surfacing within the Habitat. Time spent within the Habitat or chamber shall not be logged by AAUS.
- Aquarium: An aquarium is a shallow, confined body of water, which is operated by or under the control of an institution and is used for the purposes of specimen exhibit, education, husbandry, or research. (Not a swimming pool)

Incident Types:

- Hyperbaric: Decompression Sickness, AGE, or other barotrauma requiring recompression therapy.
- Barotrauma: Barotrauma requiring medical attention from a physician or medical facility, but not requiring recompression therapy.
- Injury: Any non-barotrauma injury occurring during a dive that requires medical attention from a physician or medical facility.
- Illness: Any illness requiring medical attention that can be attributed to diving.
- Near Drowning/ Hypoxia: An incident where a person asphyxiates to the minimum point of unconsciousness during a dive involving a compressed gas. But the person recovers.
- Hyperoxic/Oxygen Toxicity: An incident that can be attributed to the diver being exposed to too high a partial pressure of oxygen.
- Hypercapnea: An incident that can be attributed to the diver being exposed to an excess of carbon dioxide.
- Fatality: Any death accruing during a dive or resulting from the diving exposure.
- Other: An incident that does not fit one of the listed incident types

Incident Classification Rating Scale:

- Minor: Injuries that the OM considers being minor in nature. Examples of this classification of incident would include, but not be limited to:
    - Mask squeeze that produced discoloration of the eyes.
    - Lacerations requiring medical attention but not involving moderate or severe bleeding.
    - Other injuries that would not be expected to produce long term adverse effects on the diver's health or diving status.
- Moderate: Injuries that the OM considers being moderate in nature. Examples of this classification would include, but not be limited to:
    - DCS symptoms that resolved with the administration of oxygen, hyperbaric treatment given as a precaution.
    - DCS symptoms resolved with the first hyperbaric treatment.
    - Broken bones.
    - Torn ligaments or cartilage.
    - Concussion.
    - Ear barotrauma requiring surgical repair.
- Serious: Injuries that the OM considers being serious in nature. Examples of this classification would include, but not be limited to:
    - Arterial Gas Embolism.
    - DCS symptoms requiring multiple hyperbaric treatment.
    - Near drowning.
    - Oxygen Toxicity.
    - Hypercapnea.
    - Spinal injuries.
    - Heart attack.
    - Fatality.

Annex IV: Reports and documentation from training workshop held in Saint Vincent and the Grenadines from August 6th to 24th 2013

Annex IV.1: Mock Survey Report and Recommendations

TRAINING IN UNDERWATER VISUAL SURVEY METHODS FOR EVALUATING THE STATUS OF *STROMBUS GIGAS*, QUEEN CONCH STOCKS

Project ref. N° CAR/3.2/B.14

Assessment of the Queen Conch Population in the Southern Grenadines from Underwater Visual Surveys

Key Experts: Martha Prada, and Robert Glazer

Participants: Lucine Edwards, Elodie Fernandez, Trovan Ferary, Lorenzo George, Albert Hanson, Olando Harvey, Jean Christin Henry, Kirs Isaacs, Carlina Laborde, Jeremie Saunders, Ricardo Morris, Hillroy Simon, Marsha Vargas, Sarita Williams-Peter.

St. Vincent and the Grenadines, September 2013

Table of Content

Introduction

Queen conch, *Strombus gigas*, is one of the most important fisheries in the Caribbean region. Populations of conch can be found throughout the Caribbean from the northern coast of South America, northwards through the Lesser Antilles and Central America, and northwest as far as Bermuda. Queen conch is commercially exploited in at least 22 countries throughout the region, with an estimated landing of about 60 million USD. The fishery represents a significant source of income to fishers and creates jobs for the processing and marketing, ornamental, tourist, and restaurant industries in the region. Annual regional harvests for conch meat range from 4,000 MT to 10,200 MT. Significant numbers of conch shells have been exported from the region, with much of the activities originating from Haiti, The Bahamas and the Turks and Caicos Islands (FAO 1999).

In the last 30 years the overall harvest of conch has increased substantially, largely driven by international market demand, as well as growing resident populations, increasing tourism in the Caribbean region, and the expansion of the fishery into previously unexploited deeper waters. These factors have been the main contributors leading to a dramatic decline in conch population densities in several Caribbean countries. This led to the inclusion of queen conch on Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) in 1992. Since then, CITES has progressively increased pressure on states to adopt resource management and trade related measures to protect and conserve the stocks and to ensure sustainable utilization and trade in the species, including issuance of a CITES export permit for all international trade (Theile 2001).

There are a number of regional and international treaties and agreements to ensure the sustainable use and trade of queen conch. At the international level are the CITES and the Protocol concerning Specially Protected Areas and Wildlife of the Cartagena Convention (SPAW Protocol). At the regional level, several organizations are promoting regional management of the queen conch resources; namely, the Caribbean Regional Fisheries Mechanism Secretariat (CRFM), Caribbean Fisheries Management Council (CFMC), FAO, and several universities and scientific institutions.

According to data obtained directly from countries involved in the training, the annual harvest of conch ranged from 2,127 to 5,841 MT during the 1990s, while correspondingly higher harvest amounts had been reported to FAO (Tewfik 2002). The data from countries are not believed to reflect the harvest of conch by subsistence fisheries and illegal harvests. Jamaica and the Dominican Republic are the largest producers of queen conch meat with each country reporting annual landings of about 1,000 MT, followed by Turks and Caicos Islands (737-965 MT per year) and the Bahamas (453-680 MT), and finally Belize with an annual harvest fluctuating between 138-257 MT/year. The queen conch fishery in CARIFORUM countries is predominantly artisanal. In St. Lucia and St. Vincent and the Grenadines conch is targeted by a limited group of divers. In The Bahamas, Antigua and Barbuda, and St. Vincent and the Grenadines, fishers target conch primarily during the closed season for spiny lobster. On the other hand, in Dominica and Barbados, conch is fished opportunistically. In Jamaica, Belize, Dominican Republic, and Turks and Caicos Islands, conch is a major target species for artisanal and industrial vessels the production of which is supported by a developed processing sector that is export oriented. The main fishing gears are SCUBA and compressor (Hookah) diving techniques, except in Belize where these gears are prohibited. In areas where the fishery is more artisanal, harvesting is done by free diving (Theile 2001).

The status of the queen conch fishery in CARIFORUM counties varies from stocks that appear to be over-exploited to stocks that are considered to be stable. In an effort to manage the fishery, CARIFORUM countries implemented various regulations, including: minimum size restrictions, seasonal closures, gear and vessel restrictions, quotas, and limited entry (Appeldoorn 1997). Although these regulations are in place, there are still a number of concerns: poachers/ illegal fishing; lack of enforcement of existing regulations; inadequate legislation to support implementation of CITES recommendations; the use of modern diving technology, allowing fishers to access the deepest areas (> 30 m) of adult conch habitat which were once spawning stock refugia; and unsafe diving practices as a direct result of no formal dive training, deeper and prolonged diving, poorly maintained equipment, limited understanding of diving techniques, etc.; and overfishing to supply international demand for conch meat.

CRFM Member States have identified the need for a common regional approach to manage their queen conch fishery, with main issues being: Illegal, Unreported and Unregulated fishing activities, including poaching and illegal trade; monitoring of the conch natural populations and level of fishing and trade, control and surveillance; enforcement; the nature and extent of resource sharing of larval stages; and regional cooperation in management, including the harmonization of management regulations such as a closed season which could help to reduce illegal fishing. These issues could be addressed and effectively reduced at the regional level with the cooperation and commitment of Member States, and to support this decision, the CRFM Secretariat has taken on the task of coordinating conch management in the region. The overall objectives of queen conch management, as identified by Member States, are conservation of the species, sustainable harvest, and re-building of stocks, where depleted. In order to achieve these objectives, the CRFM Secretariat established the annual scientific meetings to examine information and data from important commercial species to determine their status, and if management objectives are being met. The findings and recommendations of these meetings guide fisheries management and decision-making. The Conch and Lobster Resource Working Group (CLWG) is one of five working groups that conduct fisheries assessments, and it currently strives to provide advice on conch stock/population status and to facilitate the development of appropriate management strategies.

As mention above, to improve the management of queen conch in the region, Member States need to increase their effort to develop or improve existing data collection systems that will enable better assessment of queen conch impact and population status (CFRAMP 1999). Although many countries have production information data systems, gaps still exist and very little information on spatial distribution and abundance is currently available. The importance of developing strategies to improve catch-effort data systems (ie, vessel logs, fisher's interview, processing plant reports, and/or direct sampling at landing sites) and other fishery biology aspects (ie, morphometry, genetics, reproduction, disease) is well recognized. However, there is an emerging recognition that a fisheries-independent monitoring program based on data (underwater census) is also important given the biological complexities of the species and this approach is still lacking for the majority of the countries.

Visual surveys are useful in verifying the results of catch-effort analysis, providing fisheries independent details on population structure, and estimating exploitable biomass as well as levels of recruitment. Within the CARIFORUM region, queen conch visual survey assessments have been done in Antigua and Barbuda, Bahamas, Belize, Dominican Republic, Haiti, Jamaica and Saint Lucia, applying relatively similar field methodology, but differ in their data analysis. However, other countries, Grenada, St. Kitts and Nevis and St. Vincent and the Grenadines have no previous experiences in conducting these underwater visual surveys to complement the queen conch assessments. Therefore, the regional implementation of underwater visual censuses still needs to build on the experiences, methodologies, and data analysis used in the other islands.

This report presents activities and results of a mock survey completed for the project entitled "Training in Underwater Visual Survey Methods for Evaluating the Status of *Strombus gigas*, Queen Conch Stocks' funded by the ACP Fish II Programme, European Union, as part of a regional training exercise designed to provide an opportunity to share best practices and experiences in the use of visual survey techniques. The goal of the mock survey was to determine a sustainable Total Allowable Catch or TAC for the Grenadine Islands around Union Island, Mayreau, and the Tobago Cays. Ultimately this approach will support the objective of harmonizing visual survey techniques and assessments for queen conch in the region that will be supported by the Caribbean Regional Fisheries Mechanism (CRFM).

Study Area

St. Vincent and the Grenadines is an archipelago comprised of 34 islands and islets located in the Eastern Caribbean at approximately 13° 15'N, 61°12'W. St. Vincent, the mainland, is 133 sq. miles. The Grenadine islands lie atop of the Grenada Bank which spreads forty miles to the southwest and comprise an area of approximately 17 sq. miles. The Grenadine Islands are a transboundary island chain and consist of a number of privately and state-owned islands. Bequia, Mustique, Canouan, Mayreau, Union, Palm (Prune) Islands and Petit St. Vincent are inhabited. Four other uninhabited islands make up the Tobago Cays Marine Park which is also under the jurisdiction of St. Vincent. St. Vincent and the Grenadines are flanked by Barbados 100 miles to the east, St. Lucia 24 miles to the north, and Grenada 75 miles to the south.

The mock survey was conducted in a section of the southern Grenadine Islands, covering an area of approximately 23,679ha (Figure 1.) The survey areas comprised locations immediately surrounding Union Island, Mayreau, and included the Tobago Cays Marine Park. The area was selected because this of the abundant conch stocks, it has traditionally supported an artisanal fishery, it encompasses a broad variety of benthic habitats, and there is sufficient diving infrastructure to complete surveys using SCUBA.

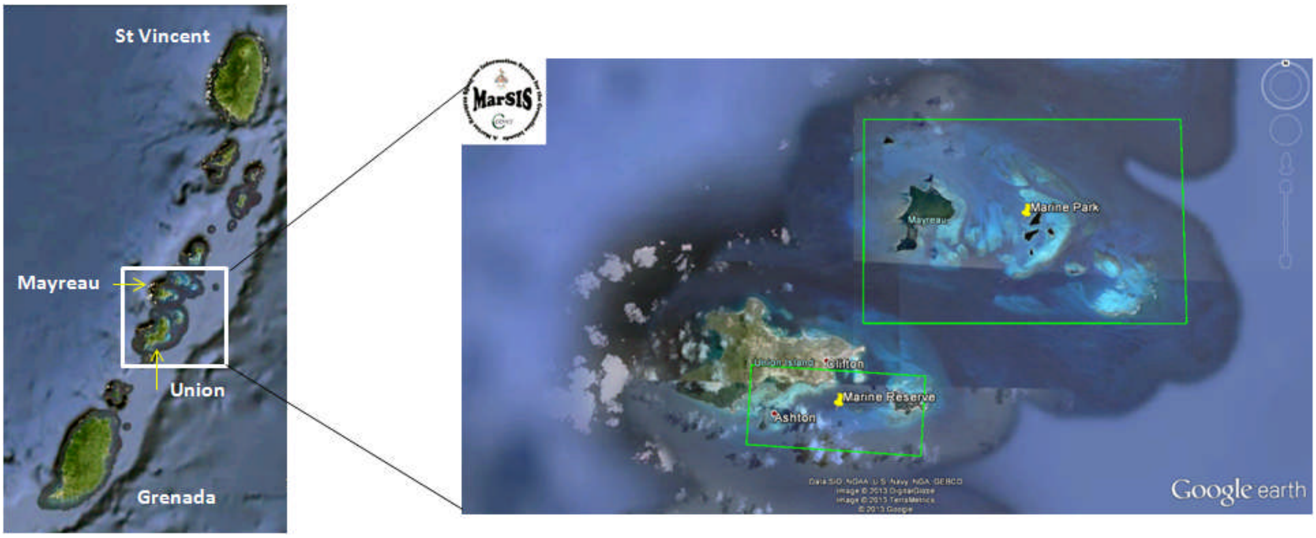

Figure 1. General location of the study area in the Eastern Caribbean. Images taken from Google Earth with MPA boundaries taken from MARSIS (http://www.grenadinesmarsis.com/).

Methods

Sampling design

The shallow water queen conch population was surveyed using SCUBA techniques and followed a stratified random sampling approach. Due to safety considerations, it was agreed that diving would take place at a maximum depth of 80 ft (24m) with sampling partitioned within strata related to the level of protection (protected or not protected) and the level of fishing (fished or unfished). Habitat was not used as a strata for sample design because there were no maps that had habitats scaled appropriately, or habitat classes suitable, for queen conch sampling.

Nevertheless, digital maps in Shapefile format were essential to define the exact survey area. A total of 80 random locations pre-selected to be surveyed in this mock survey, from which at least 50 sites were expected to be censed. Digital maps were obtained from the geo-database Grenadines MARSIS (http://www.grenadinesmarsis.com/) developed by the University of the West Indies (Figure 2).

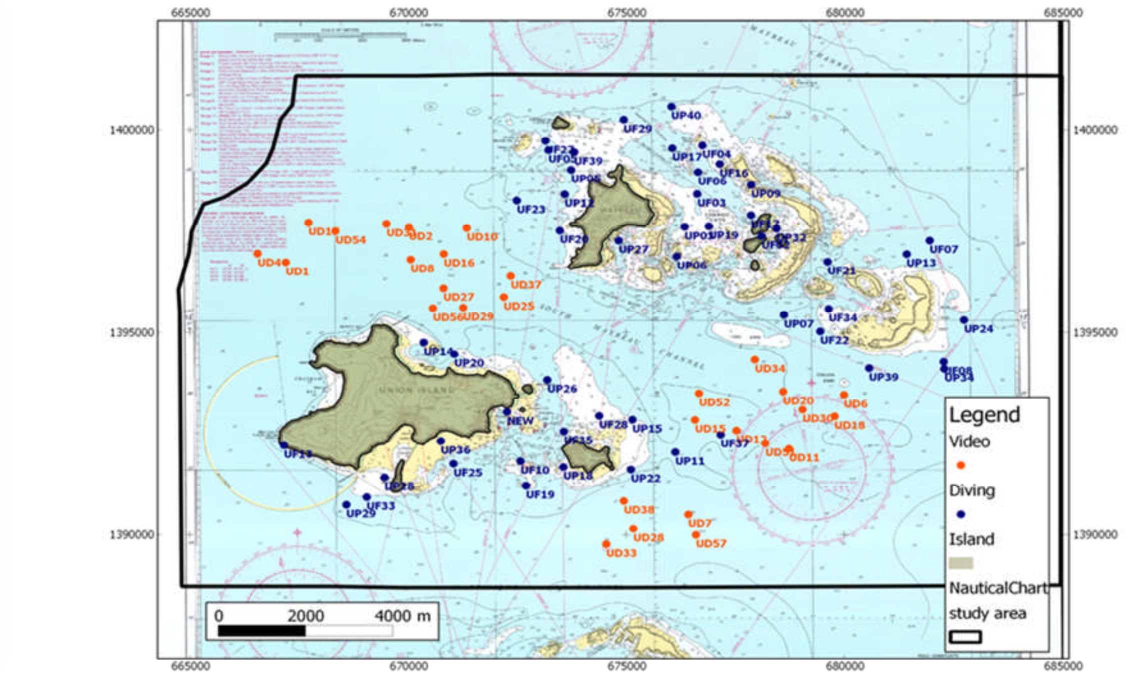

Figure 2. Locations surveyed during the mock survey in the Greadines. 51 dive sites (blue) and 29 towed-video locations (orange) are displayed over the Central Grenadines British Nautical Chart 794P available at the MARSIS geo-database (http://www.grenadinesmarsis.com/).

The deep water queen conch population was observed from a Sea viewer towed video system rented from University of the West Indies. Additional 60 random points were preselected from the deep water and preferred locations (Figure 2).

Survey locations were selected using the open source freeware GIS program Quantum GIS (www.qgis.org) using the Random Points operation within the Research Tools. A total of 51 points were allocated based upon the strata within which they were found (Figure 1).

Underwater surveys in shallow waters using SCUBA

The underwater visual census were conducted from two vessels: a 29ft vessel with an enclosed cabin carrying three dive teams (each diving team consists in one experienced and another less experienced person) and a 23ft vessel with two dive teams. In addition to the captain, a dive master and one conch survey instructor (KE) was onboard to support the diving activities. Diving was conducted from 10 August 2013 through 17 August 2013.

We used belt-transect methods to sample queen conch. The location of each site was identified in the field using a handheld GPS with the sites preloaded. One individual familiar with the GPS unit was selected to work with the vessel captain to navigate to the starting location of each transect. When the origin of the transect was identified, a buoy was deployed from the vessel to mark the starting point of the transect. A team of 2 SCUBA divers plus a safety diver then descended to the location of the origin of the transect to begin the survey.

Each transect consisted of a maximum of four replicates (30 meters x 4 m). A 30m fiberglass tape was deployed in one direction by the first diver (Figure 3). Simultaneously, a second diver swam along the length of the tape and, using a 1-m PVC pole to measure the width of the transect, sampled all conch within a 2-m swath along the right side of the transect line (Figure 4). When the diver measuring the conch reached the end of the replicate, the same procedure was conducted on the opposite side of the 35-m tape. However, at this point, the roles of the divers were reversed; the diver who deployed the transect tape became the diver measuring conch and the diver measuring the conch rolled in the tape. Only conch that were more than halfway into the 2-m width of the swath were counted. All replicates in a transect were pooled for analyses

Morphometric measurements consisted of two parameters: a) total siphonal or length shell using a large caliper or a hand-made conch-meter (in both centimeters or inches); and b) lip thickness using a smaller vernier caliper. Lip thickness was measured for all conch (Figure 4). Together, siphonal length and lip thickness formed the basis for determining maturity of the conch.

Upon completion of the survey, the divers ascended together back to the vessel. For dives greater than 30 ft water depth, a safety stop at 15-20 ft for 3 minutes was conducted.

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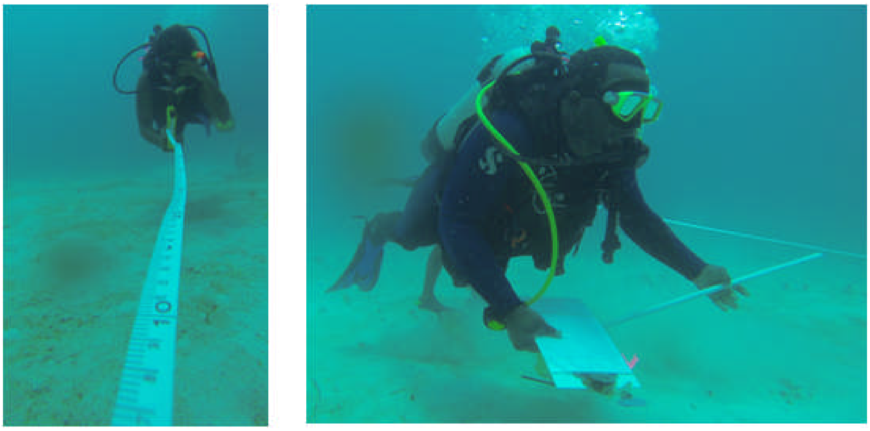

Figure 3. A diver reels in the 30-m tape (l). A second diver (r) examines a swath 2-m in width from the transect line.

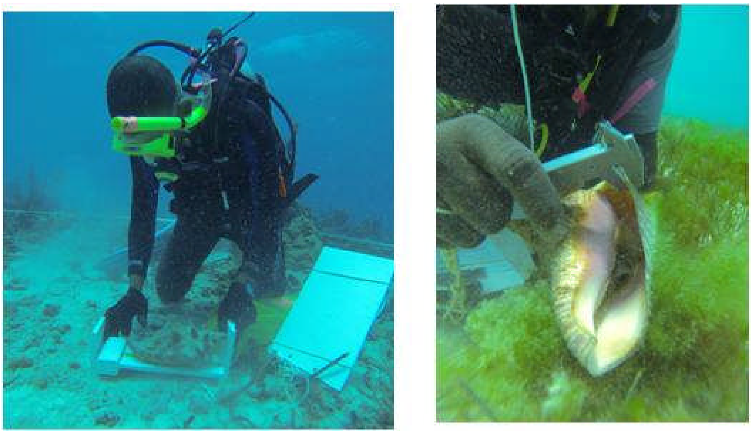

Figure 4. Measuring siphonal length of a queen conch (left) and lip-thickness (right).

Additional data on site depth profiling, bottom time, and water temperature was recorded for each location using a Reef-Net Sensus sensor (http://reefnet.ca/products/sensus/) attached to a diver Buoyancy compensator (BC). Divers made annotations on site habitat type, observations of other conch or conch outside the transects, conch reproductive activity, or any other environmental conditions.

Each night, the data was entered into an Excel spreadsheet for subsequent processing.

Observations in deeper waters

The training in the deeper waters was conducted from the 18 August 2013 through 21 August 2013 using a Sea Viewer drop-camera video system (www.seaviewer.com). Training began with a brief session conducted onshore to review the system components (Table 1), set-up the gear, and discuss and plan the deep-water video conch survey methods (Table 2).

Data collection extended over a two-day period, in which the group was divided in two teams; each team conducted surveys for ½ day in the vicinity of Union, Palm and the Tobago Cays (Figure 2). As was the case with theSCUBA survey designs, Quantum GIS was used to select sampling locations. A random sampling design stratified by depth and by fishing preferred sites was emplyed. A total of 60 deep-water survey sites were identified of which 29 were surveyed.

Deep water sites were conducted aboard a 29' cabin cruiser. Each site was surveyed by a research team comprising at minimum of six persons, including a captain, navigator, DVR video operator, data recorder, and a person to deploy the drop-camera assisted by a deckhand. Participants took turns conducting each of the various roles during the surveys. Benthic habitat was observed and assessed at each site using a towed submersible SeaViewer video camera, illuminated with LED lights. Imagery was collected in real time via a 75m cable tethered to the surface. The camera equipment was rigged within a weighted PVC cradle (Figure 5) to protect it, and set mostly perpendicular to the seafloor. The camera was tilted at a slight angle (20°) in order to provide a 'landscape-view' across the substrate. Deployment of the video camera apparatus always occurred off the stern of the vessel (Figure 6) and was handled by a two person team, in order to prevent entanglement. The deployment procedure at each deep-water survey site required that the vessel was held relatively stationary.

Table 1. Video drop-camera components, accessories and materials required for the deep water conch surveys.

Component	Accessories	Materials
Underwater Video Camera (with LED lights) with 75m cable	Protective cradle for camera	PVC, fishing weights, stainless steel fishing wire
SeaTrac GPS Video Overlay	GPS (2)	1 for SeaTrac; 1 for boat navigation
DVR Screen (or laptop)	Hard drive to record survey footage	
Converter	To power Video camera and DVR (Power source: 110)	Rigged with clamps to use power from the 12V boat battery

The tow speed controlled by the speed of the vessel as it drifted and, was therefore a function of the wind speed and current. The video footage was recorded and viewed in real-time on deck using a portable DVR screen (Figure 7). GPS tracking was recorded as an overlay on the video as latitude and longitude coordinates.

Real-time viewing allowed the operator to hold the camera approximately 1m off the seafloor to obtain consistent images (approximately similar landscape perspective at each site). A minimum of 3 minutes filming time was recorded at each site including the decent and ascent of the video camera in order to accurately assess the most prominent habitat type. Information recorded for each site (Figure 8) included: time, location and water depth to the nearest foot using a hand-held depth sounder; a video representation of the habitat; habitat type; and benthic coverage or density of habitat (low, medium, high). All recorded video footage was overlaid with the date, time, GPS location and vessel speed using a Sea-Track GPS Video Overlay. The video footage was subsequently downloaded and reviewed by the training team on-shore each evening. A total of 29 video surveys were completed (Table 3) . The Sensus depth/temperature sensor was also attached to the camera system for better recording of the environmental data.

Table 2. Summary of the drop-camera survey methods and considerations.

Methods	Considerations
Survey Team (3 person minimum)	Boat captain (GPS pre-loaded with survey sites); Data collector (DVR screen / data sheet); Deploy drop-camera
Site selection / sampling design	Random; stratified by depth, habitat type, fishing ground
Survey methods	Point / transect; drift / tow; minimum recording time at site; deployment and recording protocol
Data sheet	Field data sheet; video interpretation sheet
Converter	Video; GIS conversion; density and abundance

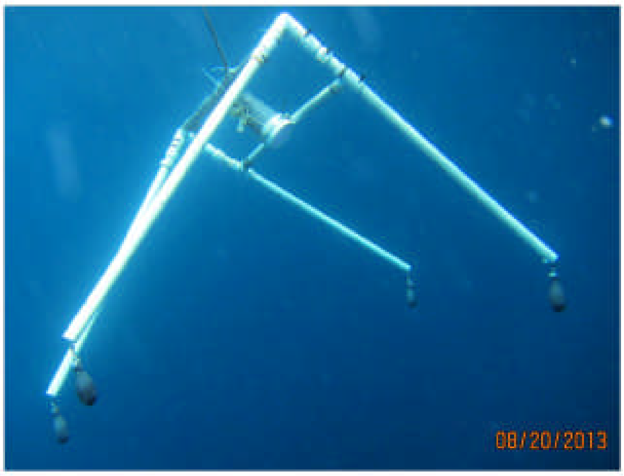

Figure 5. Photograph of deep water survey showing set up of submersible live-action SeaViewer underwater video camera rigged with weighted PVC cradle.

Figure 6. Photograph of deep water survey showing deployment of submersible live-action SeaViewer underwater video camera off the stern of the vessel.

Figure 7. Photograph of the GPS navigator and filling in of the data sheet during the conch survey.

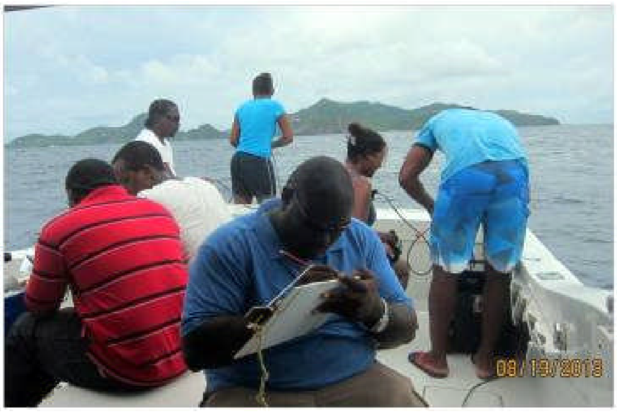

Figure 8. Photograph of the Conch survey training team conducting a deep water conch survey.

Table 3. Video transect raw data

Site #	lat	lon	x	y	Date	WP-GPS #	Video #	Time in	Depth site (m)	Depth camera (m)	Temp °C	Habitat Class	Description	%Cover
UD1	12.630143	-61.460549	1396726	667202	8/19/2013	UD1S/UD1E	619	16:45	33.03	33.7	28.21	Gravel and sand		high
UD10	12.637595	-61.422330	1397576	671349	8/19/2013	281/282	136	0:01	27.58	25.38	28.37	Reef, sand	2 legs broke	
UD11	12.587892	-61.354661	1392122	678735	8/20/2013	285/286	6	10:31		17.81	29.89	Reef		high
UD12	12.592014	-61.365740	1392571	677528	8/20/2013	300/301	115	11:40		19.50	28.65	Macroalgae		
UD15	12.594453	-61.374454	1392835	676580	8/20/2013	304/305	136	12:02		18.86	28.56	Gravel and sand		med
UD16	12.631836	-61.427220	1396935	670822	8/19/2013	279/280	126	11:51	31.52	28.98	28.39	Reef, sand		medium
UD17	12.638965	-61.455708	1397705	667722	8/19/2013	UD17S/UD17E	557	16:22	35.76	33.09	28.14	Reef, marcoalgae		high
UD18	12.595092	-61.344994	1392925	679780	8/20/2013	287/288	17	10:42		17.10	29.28	Gravel and sand		high
UD2	12.637824	-61.434512	1397593	670026	8/19/2013	UD2S/UD2E	531	15:56	36.36	31.73	28.28	Reef, sand		medium
UD20	12.600624	-61.355815	1393530	678601	8/20/2013	294/295	43	11:08		19.90	28.84	Gravel and sand		low
UD25	12.622095	-61.414605	1395866	672199	8/19/2013	270/271		11:01	37.88	35.93	28.1	Reef, marcoalgae		
UD27	12.624141	-61.427317	1396084	670816	8/19/2013	277/278	114	11:40	30.91	30.99	28.32	Reef, sand		
UD28	12.570242	-61.387612	1390148	675167	8/20/2013	UD285/UD28E	409	2:36	26.36	23.99	28.74	Reef, sand		low
UD29	12.619779	-61.423183	1395604	671268	8/19/2013	273/274	101	11:18	30.00	28.39	28.11	Reef, sand	saw sting rays	
UD30	12.596624	-61.351757	1393090	679044	8/20/2013	291/293	33	10:58		16.81	29.04	Gravel and sand		low
UD31	12.638618	-61.439265	1397678	669509	8/19/2013	UD31S/UD31E	540	16:04	32.42	32.37	28.3	Reef, sand		high
UD33	12.566826	-61.393333	1389766	674547	8/20/2013	UD335/UD33E	418	2:43	24.55	20.36	28.65	Reef		high
UD34	12.607813	-61.361744	1394321	677952	8/20/2013	296/297	54	11:18		22.87	28.78	Hard bottom, macroalgae		high
UD37	12.626815	-61.413129	1396389	672356	8/19/2013	UD37S/UD37E	506	15:32	30.30	28.27	28.78	patch reef, seagrass	high density(camera angle not good, need readjusting)	high
UD38	12.576450	-61.389586	1390833	674948	8/20/2013	UD385/UD38E	335	2:00	25.76	21.72	29.67	Reef, sand		low
UD4	12.632117	-61.466507	1396941	666554	8/19/2013	UD4S/UD4E	608	16:33	36.06	35.71	27.93	Reef, sand	omit first minute	medium
UD51	12.589125	-61.359663	1392255	678191	8/20/2013	298/299	106	11:31		19.56	28.83	Gravel and sand		
UD52	12.600354	-61.373573	1393488	676672	8/20/2013	302/303	127	11:52		26.00	21.47	Gravel and sand		
UD54	12.637055	-61.450053	1397498	668338	8/19/2013	UD54S/UD54E	549	16:14	33.33	31.38	28.19	Reef, sand		high
UD56	12.619698	-61.429587	1395591	670573	8/19/2013	275/276	102	11:28	29.09	26.57	28.22	Reef, sand		
UD57	12.568776	-61.374412	1389994	676602	8/20/2013	UD575/UD57E	358	2:24	26.36	25.76	28.84	Gravel and sand		med

UD6	12.599843	-61.342979	1393452	679996	8/20/2013	289/290	24	10:50		16.79	28.67	Reef, sand	Saw a conch	low
UD7	12.573359	-61.375989	1390500	676427	8/20/2013	UD75/UD7E	348	2:14	26.67	19.1	28.91	reef, medium		med
UD8	12.630612	-61.434193	1396795	670065	8/19/2013	UD8S/UD8E	519	15:46	30.30	30.14	28.33	Reef	omit first 2 1/2 minutes	med

Estimation of Total Allowable Catch (TAC).

The goal of the survey program was to determine the TAC. However, in order to make this estimation, the total biomass needed to be estimated. To estimate total biomass, we first determined the area to which the TAC was to be applied. This area was estimated within Quantum GIS using the maps downloaded from the Grenadines MARSIS webpage. The following steps were completed using Microsoft Excel except where noted and are modified from the queen conch manual:

1. The overall area to which the TAC was to be applied was determined within QGIS. The area of each strata (protected versus unprotected, and fishing vs. unfished) was also determined within the GIS.

2. We then summarized the number of conch per station, discriminating between adults and juveniles. Individuals with lip thickness less than 10mm were to be considered juveniles.

3. Estimation of total area surveyed. This was calculated at the station level by multiplying the width of the transect by the overall length of the transect determined from all replicates.

4. The density of conch per station was then determined by dividing the total number of conch by the total area surveyed. Three density values were obtained: adult, juvenile and total conch. For each case, the following formula was applied:

$$d_s = X_s / a_s$$

Where:
x_s =Total number of conch found in the station
a_s = Total surveyed area per station

5. The conch densities were grouped by sampling strata and descriptive statistics were calculated for each stratum. These parameters included mean density, variance, standard errors, confidence limits of the estimation.

6. We then extrapolated densities from sampling stations to the entire surveyed area. We also estimated the proportion of each stratum area and calculated weighted densities by applying the following formula:

$$D = \Sigma\, d_e \; * (A_e / A)$$

Where:
A_e = Total area by stratum
A = Total area
d_e = Density by stratum

7. We then estimated the total abundance using the sum of the weighted densities multiplied by the total area.

8. We then evaluated the fishing potential of the conch stock by comparing the calculated density estimates against pre-established density reference points, following the recommendations from the last conch CITES, CoP16, resolution “Regional Cooperation on the Queen Conch Management of and Trade” in which they adopted the recommendations from Queen Conch Expert Workshop (May 22-24, 2012, Miami, USA). They recommended that a conch fishery was possible in cases where the

mean/median adult density is 100 conch/ha or higher. Lower density values indicate significant risk that recruitment will be impaired, and therefore special management measures might be required. This reference point may change at different locations depending on the availability of data (e.g., site-specific reproduction at density), but no fishing is recommended if adult densities are less than 50 conch /ha. a threshold previously determined for successful queen conch reproduction (Stoner and Ray-Culp, 2000).

9. Because densities exceeded 50 conchs/ha, we applied the 8% rule wherein the estimated mean/ median fishable biomass was used to set a precautionary sustainable yield.

10. We then developed frequency histograms based on size classes of all conchs in all the surveys. The frequency histograms provided a quantitative method of determining the relative contribution to overall biomass from each size class.

11. We then calculated the fishable biomass by applying the following formula:

$$\text{Biomass} = \Sigma AL * WL$$

Where:
AL = abundance of conch size class (total length)
WL = Conch average weight on a given size class

However, to calculate the WL, it is necessary to apply a length-weight relationship (Weight = a*bLength or ln(Weight) = a + b*ln(Length).

We used the following values as our conversion values.

Location	**Constant (a)**	**Coefficient (b)**	**Reference**
Puerto Rico	-1.51	2.804	Appeldoorn 1988

We considered that the fishable biomass only included conch in those size-classes within which fishing is allowed. Conch in size-classes for which fishing is prohibited are not considered part of the fishable biomass. In many locations, juvenile conch are not permitted to be harvested and would therefore not be considered as part of the fishable biomass.

12. Once the total conch biomass was estimated, the 8% harvest control rule was applied. This rule follows the recommendations of the Regional Cooperation on the Queen Conch Expert Workshop. To this amount additional restrictions should be applied.

13. A meat conversion factor was then applied to the total harvest in order to calculate the TAC. The conversion factor was required because the meat is trimmed to remove the viscera and the hide is peeled We used the conversion factor presented by Aspra et al (2009).

Processing grade	Conversion factor to nominal weight
Dirty	5.7
50% clean	9.5

85% clean	13.7
100%	16.3

14. To develop the final TAC, we considered additional restrictions based on several criteria. One of those was the extent of the bank. Further reductions are necessary to apply harvest and trade control rules such as: a) 8% control harvest rule over the population biomass (Medley 2008, Smikle 2010, CITES CoP 16); b) fishing recommendation only if the adult conch density threshold is met (50-100 ind/ha accordingly with CITES Queen Conch Resolution CoP 16, Stoner and Ray- Culp 2000); c) application of the conversion factors for meat trade as recommended by Aspra et al (2009); and d) an additional 20% discount to account for illegal fishing, a value that was set arbitrarily until a better local estimation becomes available. The use of these criteria incorporates the recommendations given at the Queen Conch Expert Workshop and later adopted by CITES on its Regional cooperation on the management of and trade in the queen conch (*Strombus gigas*) Resolution (CoP 16 Thailand, 3-14 March 2013). GIS analysis and products were obtained using Quantum GIS, and maps were downloaded from the Grenadines MARSIS webpage.

Juveniles were differentiated from adults based on the average minimum size stated in fishing regulations across the region (Table 4). This approach assumes that 50% of the population have already reproduced at least once. We were confident that this approach was appropriate because the lip thickness for the surveyed population was similar to that reported elsewhere in the region. Based on this approach, the minimum size we used to categorize adult conch was based on the average size (19.6 cm) onto which we added 1-cm to incorporate a 'precautionary' buffer.

It is important to mention that the recommendation of minimum adult conch density is still under revision at the country level, and still lacks official support from St. Vincent and the Grenadines. The adoption of a regional standard is a slow process.

Table 4. Summary of the minimum shell length stated in the current fishing regulations.

Country	Fishing Regulation	Size (cm)
Antigua and Barbuda	Fisheries Act No 14 of 1983 Fisheries Regulation No 10 of 1990 Fisheries Act No 22 of 2006	18
Belize	Fishery Regulations of 2005	18
British Virgin Islands	Fisheries Regulations of 2003 Amended in 2002; 2007	17.8
Cuba		20
Dominican Republic	Law 64-00, Decree 833-03 of 2003, Law 307 of 2004	18
Grenada	Fisheries (Amendment) Regulations	18
Honduras	Ministerial Agreement 820/ 2003, 103/2005, 391/ 2006	22
Jamaica	Fishing Industry Act of 1975; 1976	22
Martinique	Regulation 994296	22
Nicaragua	Decree DGRN-PA-No 407-05 of 2005	20
Puerto Rico	Reglamento de Pesca de Puerto Rico 2010 No 7949	22.9
St Kitts/Nevis	Fisheries Regulation No 11 of 1995	18
St Lucia	Fisheries Regulation No 67 of 1987; No 9 of 1994	18

St Vincent/Grenadines	Statutory Rules and Orders Act Part 4 Sec 18 of 1986	18
Turks and Caicos		18
US Virgin Islands		22.9
Average		19.6

Results

A total of 51 stations were surveyed during the seven days of diving and, of these, 36 stations contained conch (70%). A total of 328 conchs were counted and measured. Dive stations averaged 12.3m in depth, and ranged from 1.8 to 21.0m (6ft to 69ft). Surveys times averaged 28 minutes. On average, water temperature was 28.62°C (SD=0.21°C), with higher values in shallow waters (<10m: 28.7°C) compared to deeper sites (>15m: 28.5°C).

The majority of conch were found on various types of sandy habitats (with corals, algae, grass, gravel), followed by various types of gravel habitats (with algae, corals, grass), seagrass habitats, and to a lesser extent, in coral-dominated habitats (Figures 9-10).

The size distribution of sampled conch was normally-distributed with individuals ranging from 5.5 to 26.7cm in siphonal or total length (Figure 11).

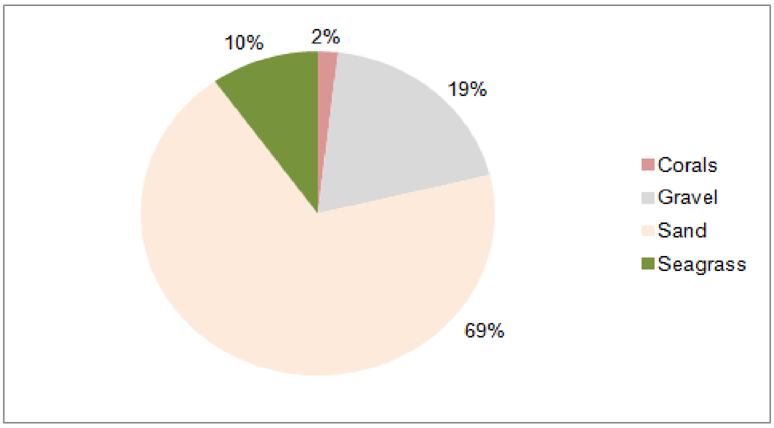

Figure 9. Habitat types associated with queen conch in the study area.

Figure 10. Photographs of habitats types where queen conch were found in the Southern Grenadines.

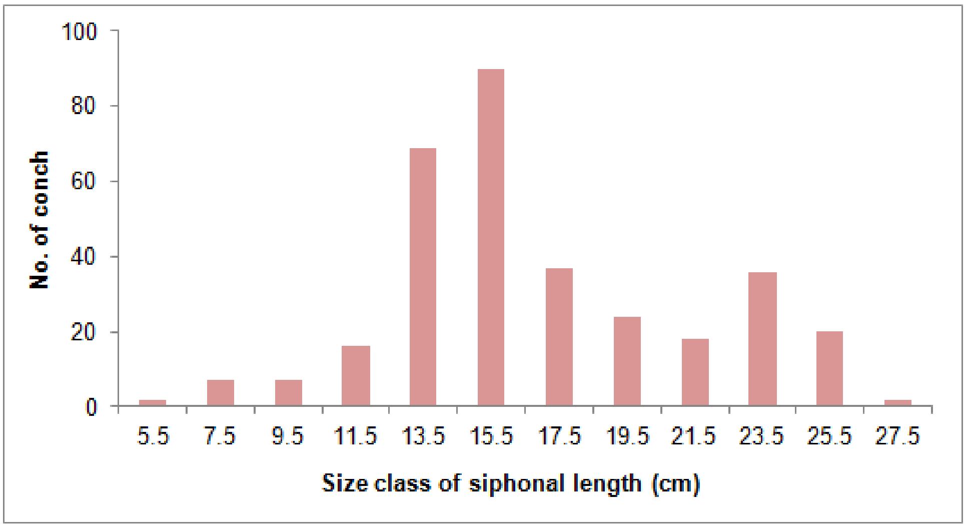

Figure 11. Size distribution of queen conch found in the study area.

The largest conch densities were found in deeper surveys (12m to 20m in depth) and in sites along channels exposed to strong currents. In comparison, sites with no conch were generally found shallower (8.9m mean water depth) and on protected environments around Union Island and on the west side of Mayreau (Figure 12). Because fishermen are using SCUBA, it appears that depth is not serving as a refugia for conch, at least in the depths and areas that were surveyed (Figure 13).

Because the majority of the preferred fishing grounds were located beyond the depths selected for this survey/training (21m or 70ft), minimal information was gathered from deeper locations. However, results from the four stations conducted in these deeper areas showed high conch densities (from 100 to 2660 ind/ha) in marked contrast to other sites. The majority of these conch were adults (Figure 14). This result suggests that there are deep conch populations that are actively reproducing, and this explains the broad size classes found in these conch populations. One female laying eggs (Figure 15) was found in station UF7 (12.63418N, -61.32468W).

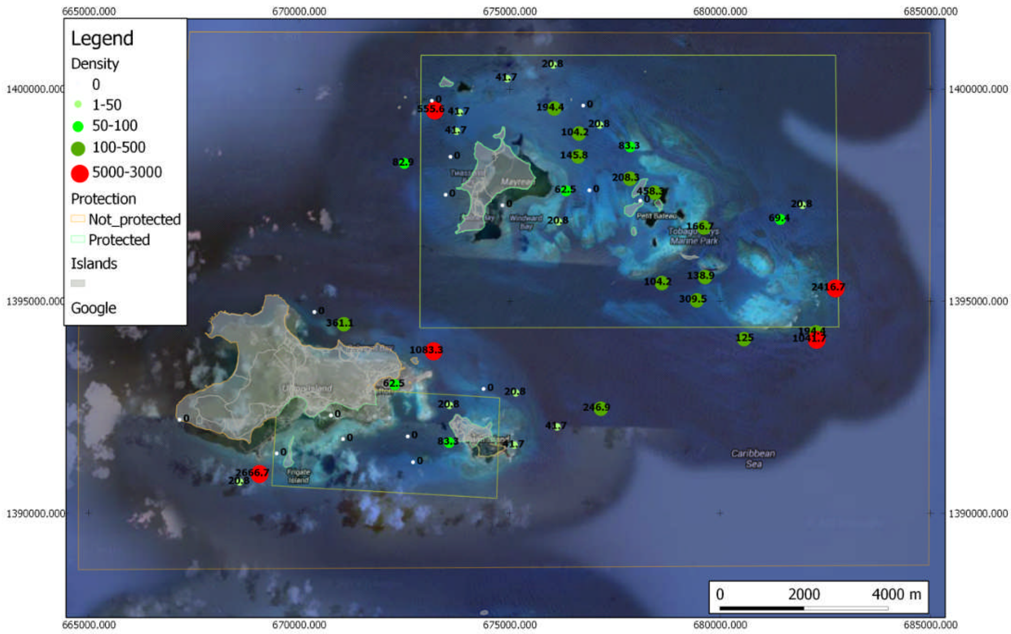

Figure 12. Spatial distribution of queen conch densities with respect to protection status in the study area.

Existing marine protected areas are presented by the areas within the rectangles. Source of information about protected areas boundaries: http://www.grenadinesmarsis.com/.

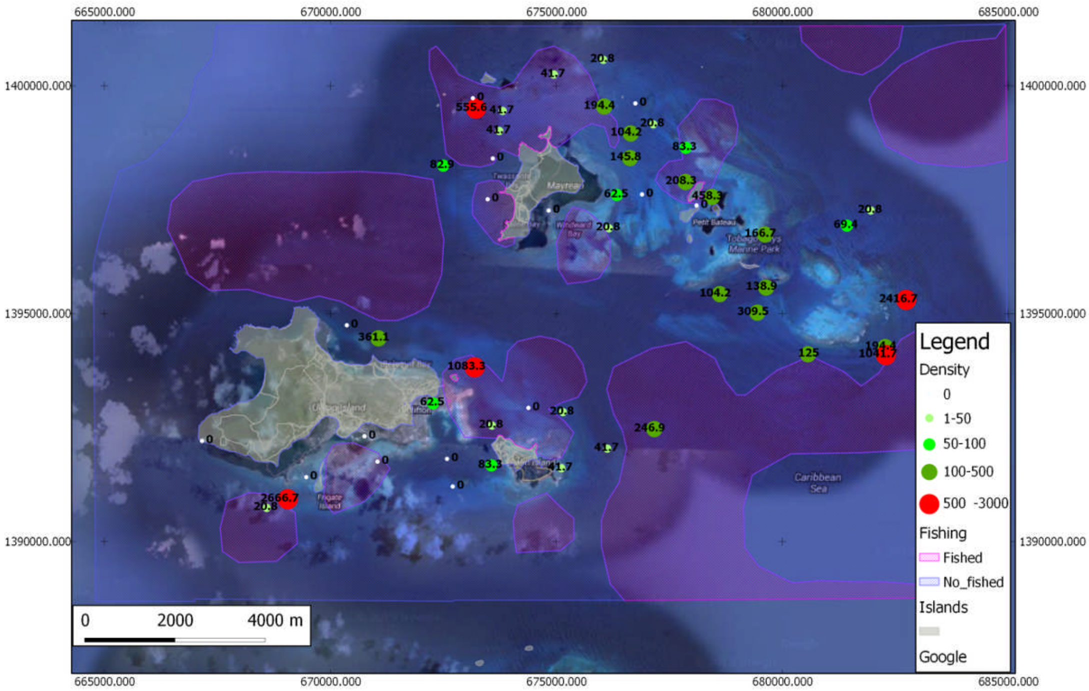

Figure 13. Spatial distribution of queen conch densities with respect to fishermen preferences in the study area. Information about preferred fishing grounds from : http://www.grenadinesmarsis.com/.

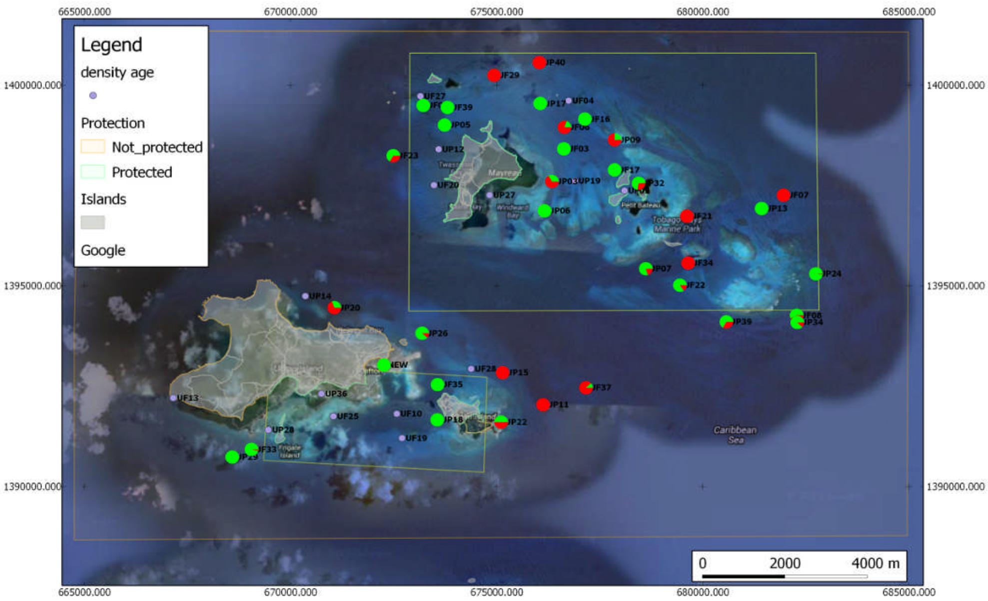

Figure 14. Spatial distribution of queen conch juvenile (green) and adult (red) densities with respect to protection status (protected or unprotected). Information about protected areas was from : http://www.grenadinesmarsis.com/

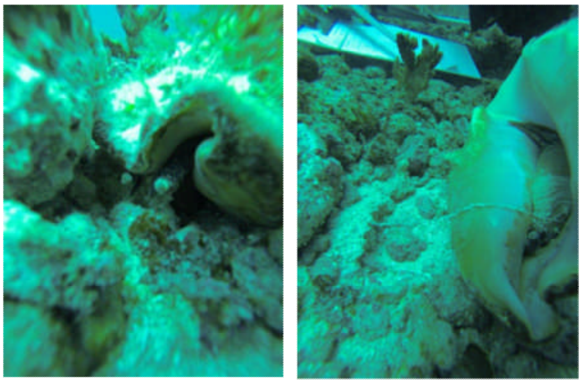

Figure 15. Female laying eggs found in site UF7 in 17m of water depth.

Towed-video observations from the 29 deeper locations were conducted at depths between 16.69 to 35.93m. Habitats there were found to be comprised of reef or hard bottom with sand pockets. These were areas where conch were expected to occur (Table 5). Unfortunately these initial tests did not have high quality video imagery due to difficulties in adjustments of the correct camera angle and the strong currents. The resolution of the camera and the interference with the electric system also played a role in reducing the quality of the imagery.

It was clear from these surveys that approaches need to be developed to address these issues. These include developing protocols for the best conditions within which these surveys should be conducted. For example, we conducted these surveys in windy conditions and in highly rugose reef type environments. The surge created by the sea conditions coupled to the complexity of the environment resulted in collisions with the reef and damage to the cameral structural support trusses. In better sea conditions, the vertical surge would likely be reduced thus resulting in decreased damage to the camera rig.

Furthermore, the analog nature of the video signals resulted in video captures with lower than optimal resolutions. There are systems that incorporate high definition signals; however, these systems require a much greater monetary investment in equipment including cameras, cables, data storage, computing power, It is not clear that the images would be much better, either. In any case, we felt that the system as used needed some more modifications to maximize efficiency and to be more useful for deepwater surveys. Additionally, selection of the most appropriate equipment should be dependent on the resources available and the nature of the local conditions.

Nevertheless, we observed at least 4 conchs, although it might be possible that the number of conch was higher (Table 5). Therefore, it was not possible to estimate the density from these areas which accounted for the majority of the study area. As a consequence, calculations of the total allowable catch (TAC) were made exclusively on the shallow water conch stock and these estimations may underestimate the true abundance and densities.

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Table 5. Characteristics of deep water sites explored with the Seaview towed video system. Temperature and depth was obtained from Reef-Net Sensus sensor.

Habitat class	No. sites	Depth (m)	Temperature (°C)	No. conch
Gravel and sand	8	22.2	27.88	1
Hard bottom, macroalgae	1	22.9	28.78	
Macroalgae	1	19.5	28.65	
Patch reef, seagrass	1	28.3	28.78	
Reef	3	22.8	28.96	
Reef, marcoalgae	2	34.5	28.12	
Reef, sand	13	27.8	28.43	3
Total	29	25.5	28.36	4

When the protection status was used as the strata for analysis, the overall density was estimated at 306 ind/ha (weighted). Higher values were found within non-protected zones with 260 ind/ha versus only 47 ind/ha found within the protected zones. However, the majority of the individuals observed were juveniles (overall density = 254 juveniles/ha) compared with only 52 adult conch/ha (Table 6). On average, the sites within the two protected areas had lower conch densities.

Similar results were found when the estimations of density considered the intensity of the fishing as the stratum. In this case, total density was estimated again at 227 ind/ha, with juveniles having on average 189 ind/ha; adults accounted for 37 ind/ha. Sites within less fished locations had higher conch densities, and relative adult densities were slightly higher there (Table 6).

Once total conch density was calculated, it was possible to estimate the population size for the selected area (23,679 ha). When the status of protection was applied, the queen conch population size was approximately 7.27 million individuals. Juveniles accounted for up to 83% of the estimate. When the fishing intensity was the stratum, the population size was estimated at 5.29 millions, with juveniles comprising 84% of the estimate.

Combining the size frequency distribution with the queen conch population size, total conch biomass was then estimated to be 1,605,219 pounds using the protection stratum, or 1,169,854 pounds for the fishing intensity stratum.

Table 6. Summary of the weighted queen conch densities (ind/ha) in the southern Grenadines, accordingly with two strata.

Extension of each strata was calculated from available maps in the MarSIS at (http://www.grenadinesmarsis.com/).

Stratum	Total	Juvenile	Adults
Protected	46.61	39.5	7.1
Not protected	259.84	214.9	44.9
Total	**306.4**	**254.4**	**52.0**
Population size	**7,256,446**	**6,023,503**	**1,231,373**

Stratum	Total	Juvenile	Adults
Preferred fishing grounds	44.2	38.3	5.9
Not preferred fishing grounds	182.0	150.8	31.2
Total	**226.2**	**189.1**	**37.1**
Population size	**5,288,361**	**4,420,642**	**867,719**

The recommendation of minimum adult conch density was found to be at the lower side, with 52-37 adults/ha, thus, applying the 50 conch/ha rule, a queen conch fishery can be recommended with caution. This recommendation is based on the expected higher densities of conch in deeper sites, where diving was not conducted. As a consequence, a better estimation of the overall adult density still needs to be produced.

The application of the 8% harvest control rule estimated the maximum exploitable biomass to be around 128,418 to 93,588 pounds depending on the strata. This amount is further reduced to 107,485 to 78,333 pounds for 100% clean meat conversion factor (16.3% recommended by Aspra et al 2009). The 100% clean meat is achieved when only white meat remains, and it is the most common export product. Further reductions to account for illegal fishing (arbitrarily assumed to be 20%) resulted in a final recommendation of 85,988 to 62,667 pounds (31.3 to 28.5 mt) for the overall total allowable catch.

The data from the surveys is included in the Annex to this report for future reference and use.

The dataset on water temperature and depth gathered from the Sensus sensor demonstrated that in general shallower waters were warmer. Waters from 5-20m in depth averaged 28.66°C whereas those in sites from 20-35.93m averaged 28.14°C. The tendency towards declining water temperatures at depth was most pronounced for data collected at deeper sites over the course of individual dives (Figure 16).

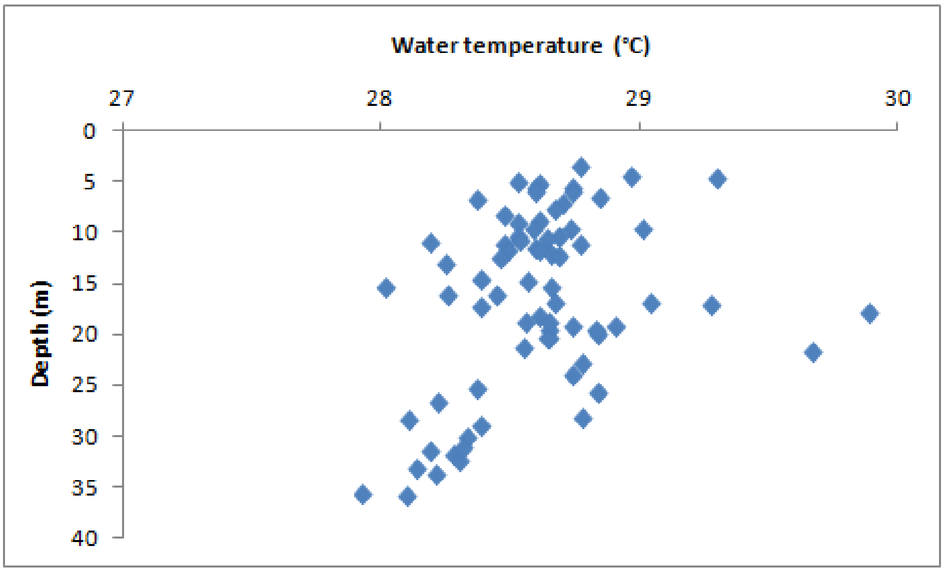

Figure 16. Scatter plot of the water temperature and depth obtained from the Sensus sensor utilized at all visited sites.

Discussion

Results found in the 2013 southern Grenadines survey indicated that the queen conch population was dominated by juveniles in the relatively shallow areas (up to 21m in depth), and by adults in the deeper, exposed areas. Unfortunately, very little information was collected at these sites. The abundance of the queen conch in this section of the Grenada bank was recognized more than four decades ago, when Adams (1970) stated that richest conch grounds are found at the central and southern banks, and described the conch populations in the northern Grenadines around Bequia, and Mustique to be much lower.

At that time, queen conch were generally found inshore around the main islands, and between the islands and fringing reefs in water depths primarily over nine fathoms (16m approximately). In particular, conch were found on the extensive sand and coral bottoms from Canouan to the south, including leeward of Union Island, the Tobago Cays, Petit St. Vincent, and the northern Carriacou. Even then, there were signs that conch were being depleted because fishermen were forced to dive deeper; for the most part, they have already reached the maximum depths for free-diving. He mentioned that by 1966, fishermen often had difficulty in locating large-sized conch in about five to seven fathoms because they relied solely on their lung capacity and physical endurance to harvest individuals. According to Isaacs (2012), all conch fishermen now use SCUBA and fish mostly during the closed season for lobster (1 May to 31 August), a fishery which is virtually unregulated. A minimum size of 18cm of shell length and the presence of a flared lip for harvest are the only fishing regulations, and both are poorly observed and enforced.

The conch fishery in the southern Grenadines is artisanal in nature. When the fishery was first developing, conch harvest was conducted daily throughout the year, except Sundays, holidays, and at market time. In addition, fishing was more restricted by unfavorable weather conditions (about two or more days each week). These conditions were a consequence of high wind speeds associated with seasonal changes. As consequence, only the leeward side of islands and reefs were frequently fished for conch. Currently, conch is fished at deeper sites by relatively few fishermen (less than 20, Kris Isaacs and Albert Hanson, personal communication) mainly during the closure of the lobster fishery.

There have been few comprehensive studies in the region that estimated the overall conch density to which we can compare our results from southern Grenadines where conch still appear to be relatively abundant in shallow waters (168 ind/ha). In St Lucia, it is believed that conch abundance in shallow-water areas is very low or non-existent (King-Joseph et al 2008). Because of that, researchers searched only for deep-water stocks in two areas (north and south) and estimated conch densities at 229.5 ind/ha in depths between 18.3 and 39.6m or 60 to 130ft. Unfortunately, no indication of the proportion of adults to juveniles was provided. In St. Lucia the conch fishery is also artisanal and conducted by only 40 fishermen with 20 boats. Predominantly large and mature conchs are harvested (FAO 2007).

In the case of Barbados, conch density was much lower with an overall mean density of 12.93 conch/ ha; juveniles comprised 87-79% of the surveyed population (Oxenford et al 2008, Oxenford et al 2010). Adults had critically low densities (0.68 - 1.39 conch/ha) for the population between 3 to 15 m in depth, with no indication of higher densities from preliminary surveys of deep-water habitats (15-30 m depth). They also reported patchy conch distribution and concluded that given the rarity of mature adults, there is a significant concern for the sustainability of this unmanaged fishery. Indeed, population size estimations were two orders of magnitude lower (34,167 queen conch) when compared to estimations in the southern Grenadines (this report).

Conch density in the southern Grenadines was also higher than densities in St. Eustatius where conch densities in shallow waters were estimated to be 167 ind/ha from 12 transects (Davis 2003), 88 ind/ha (White 2005), and 121 ind/ha from only 8 transects (van Rijn 2012). There were no statistically significant differences among them.

The normal size distribution of the local stocks, the relatively high juvenile conch density, and the expected presence of reproductive individuals at deeper sites all suggest that the population may be recovering perhaps due to a reduction in the fishing pressure. This reduction may be related to the recent implementation of the Tobago Cays Marine Park in 2006, especially at sites between the eastern side of Mayreau, and the western side of the Tobago Cays including Horseshoe Reef. These locations are inside the protected area and had relatively high juvenile densities. This stands in contrast to lower juvenile densities observed in surveys around Union Island, where a Marine Conservation Area was established in 1998, but is not yet actively managed. The Tobago Cays Marine Park was established in 1997, but it was only in 2006 that personnel and management were put in place. If this recovery is indeed occurring, more efforts are needed to ensure good enforcement and surveillance thereby allowing those juveniles to mature and reproduce. This could compensate for the fishing pressure targeting the deep-water stocks. The overall conch density within the MPA is still low compared with the non-protected areas.

Annual conch landings available from the Fisheries Department in St. Vincent (Table 7) are highly variable. This is likely the result of an incomplete dataset the result of which is making it impossible to determine with certainty the current levels of conch production. Additionally, it was not possible to estimate the current levels of illegal fishing taking place within the Tobago Marine Park and The Marine Conservation Union-Palm Island area.

It is likely that a great deal of illegal fishing originates from fishermen from neighboring countries. For example, rangers from the Tobago Cays Marine Park report that illegal fishing often is the result of fishers from the French-speaking islands (e.g., Martinique) where their stocks are already severely depleted. EU Sanitary Food Regulations restricted the import of queen conch in 1997 to the European Union (Theile 2001), but Martinique was still importing conch illegally from the neighboring islands (CITES 2003). Furthermore, Grenada has been under CITES trade suspension since May 2006 due to lack of response to CITES, (CITES 2012), thus facilitating the illegal conch trade with the Southern Grenadines.

Table 7. Annual queen conch landings and exports.

Data provided by Kris Isaacs from the St Vincent and the Grenadines Fisheries Department.

Year	Landings (lbs)	Exports (lbs)	Year	Landings (lbs)	Exports (lbs)
1990	5,545	10,945	2001	84,238	78,816
1991	3,240	84	2002	79,048	75,238
1992	4,225	21	2003	19,601	14,707
1993	62,140	72,477	2004	37,950	30,698
1994	33,422	19,586	2005	14,221	8,646
1995	17,024	13,537	2006	7,907	5,354
1996	27,404	18,160	2007	23,668	19,441
1997	18,040		2008	9,144	1,790
1998	45,774	1,100	2009	38,597	25,373
1999	15,040	5,010	2010	86,223	62,610
2000	15,212	10,239	2011	22,991	13,433

The estimation of a TAC resulted in around 30mt of clean meat. However, this amount is far smaller than the export quota enacted in 2002 which was set at 70mt. This quota was arbitrarily set and was not based on any scientific information. The fact that conch were found to be smaller, deeper and fewer than previously reported (CITES 2012) was not considered in developing the 70mt quota.

In order to effectively determine the level of harvest that would ensure sustainability, there is a critical need to improve the monitoring of landings. There is also a need to improve fisheries management cooperation with Grenada and other neighboring countries. Improved inter-island communication will have the effect of counteracting illegal fishing and would have the added benefit of providing more comprehensive understanding of conch production and harvest.

With regards to the underwater video system. the initial testing of the equipment could easily identify habitat, but identification of individual queen conch was more challenging. Similarly, it was clear that the technique using this gear is not yet perfected; however, ongoing efforts in other countries should provide systems and approaches that are more workable.

Van Rijn (2012), using towed video systems, showed a direct link between rubble/algae habitat and queen conch densities; the densities on rubble/algae had higher density than predominantly sandy transects. His results suggest that conch densities estimates resulting from a towed-video system are likely to be lower; and the difference between live queen conch, dead queen conch and milk conch were impossible to distinguish. He also recommended determining the length of the transect using the GPS track rather than the straight line between two waypoints.

Recommendations

- The queen conch stocks in the Southern Grenadines have a relatively high density; nevertheless, very few adults were found. The recent implementation of the Tobago Cays Marine Park appears to be a reason why these juveniles were seen in relative shallow and protected sites. Therefore it is recommended to keep and extend the MPA enforcement and surveillance, in order to allow these juveniles to mature and reproduce. This recommendation also applies to the Union-Palm Island Marine Conservation Zone to promote conch recruitment and therefore begin the population recovery.

- Higher adult conch densities were found only in locations influenced by extreme environmental conditions (e.g., strong currents, high swells, deeper sites); therefore, it is recommended that more fishing regulations should be developed such as a closed season and restrictions from fishing inside protected areas to reduce the targeting of the fishing on the conch reproductive stocks.

- There is a need to conduct more work in the quantification of deep-water queen conch stocks. The underwater video system needs some calibration and improvement in the imagery quality and deployment, but the tests proved this is a promising technology. Interpreters of the video-imagery need more training and the collaboration of fishermen who can recognize conch at a distance or in cryptic environments should be included as part of the image analysis. In other studies, it was determined that some observers had a tendency to be more uncertain and mischaracterize milk conch as queen conch (van Rijn 2012).

- Because the current level of conch fishing is not completely known, it is recommended that a program should be developed to monitor conch landings across the entire southern Grenadines. This survey should last at least one year, thus facilitating the estimation of total catch and also IUU fishing. This will help estimate sustainability vis-à-vis the recommended TAC. The collection of better landing data should include efforts to better estimate illegal fishing. Any reduction of illegal fishing will beneficiate the local fishers.

- In order to protect the reproductive stocks or sites with high conch recruitment, it is recommended to develop a strategy for focused enforcement. For instance, a program to approach yachts visiting the area from neighboring countries should be a priority. Integration of the fisheries and MPA personnel is highly desirable for higher efficiency and reduction of associated costs. In this respect, it is also recommended that special zones for conch recovery should be established within the existing protected areas.

- There is a need to develop more collaborative work between fisheries managers and tourism officials in order to define non-conflicting policies, particularly with respect to the extractive potential of marine resources, including the queen conch. These policies should extend to better educational practices and information targeted at tourists and fishermen.

- There should be an effort to develop for example length-weight relationships specifically for the Grenadines which can be used to better calibrate equations necessary to estimate total allowable catch.

- The current study was possible because of the integration of personnel from different sites, with different experiences and skills, demonstrating how the strategy was effective for conducting underwater queen conch surveys. It is recommended to continue conducting these censuses and to update the survey results every three to four years. The survey intervals should take into account the queen conch life cycle to ensure that no detrimental event occurs.

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ANNEX. Summary of Survey data.

SITE	LAT	LON	Y	X	Total	Juv	Adult	Area_m2	Area_ha	Adu_den	Juv_den	Total_den	Protection	Fishing	Depth
NEW	12.59649	-61.4438	1390928.87	669058.51	3	3	0	480	0.048	0.00	62.50	62.50	Not_protected	No_fished	6.3
UF02	12.63541	-61.3176	1395303.18	682744.11	0	0	0	480	0.048	0.00	0.00	0.00	Protected	No_fished	3.1
UF03	12.64489	-61.4056	1393821.65	673194.38	7	7	0	480	0.048	0.00	145.83	145.83	Not_protected	Fished	10.3
UF04	12.65572	-61.3218	1394093.01	682294.89	0	0	0	480	0.048	0.00	0.00	0.00	Not_protected	No_fished	4.5
UF05	12.65487	-61.405	1399498.40	673223.33	20	20	0	360	0.036	0.00	416.67	416.67	Protected	Fished	13.7
UF06	12.64976	-61.357	1397562.39	678447.64	5	1	4	480	0.048	83.33	20.83	104.17	Protected	No_fished	11.1
UF07	12.63419	-61.4251	1394458.88	671064.29	1	0	1	480	0.048	20.83	0.00	20.83	Not_protected	No_fished	16.8
UF08	12.60708	-61.3479	1395022.81	679451.06	7	4	3	360	0.036	62.50	83.33	145.83	Protected	No_fished	18.9
UF10	12.58546	-61.369	1392468.43	677169.74	0	0	0	480	0.048	0.00	0.00	0.00	Not_protected	Fished	10.5
UF13	12.58931	-61.4612	1392208.88	667159.71	0	0	0	480	0.048	0.00	0.00	0.00	Not_protected	Fished	13.6
UF16	12.65155	-61.3624	1397889.95	677861.88	1	1	0	480	0.048	0.00	20.83	20.83	Protected	Fished	5.5
UF17	12.64008	-61.3219	1394267.84	682280.17	10	10	0	480	0.048	0.00	208.33	208.33	Not_protected	No_fished	11.0
UF19	12.57997	-61.3789	1399544.34	676060.04	0	0	0	480	0.048	0.00	0.00	0.00	Protected	Fished	10.0
UF20	12.6369	-61.3463	1396737.80	679618.68	0	0	0	360	0.036	0.00	0.00	0.00	Protected	No_fished	11.0
UF21	12.62956	-61.3737	1398414.84	676630.93	2	0	2	120	0.012	41.67	0.00	41.67	Protected	No_fished	19.6
UF22	12.61407	-61.3461	1395572.50	679644.63	13	11	2	420	0.042	41.67	229.17	270.83	Protected	No_fished	10.7
UF23	12.64362	-61.3376	1394110.25	680571.29	3	2	1	362	0.0362	20.83	41.67	62.50	Not_protected	No_fished	15.3
UF25	12.58499	-61.3735	1398954.05	676648.30	0	0	0	480	0.048	0.00	0.00	0.00	Protected	No_fished	16.8
UF27	12.65696	-61.3555	1395430.02	678618.28	0	0	0	480	0.048	0.00	0.00	0.00	Protected	No_fished	11.0
UF28	12.59548	-61.3623	1398639.38	677865.41	0	0	0	480	0.048	0.00	0.00	0.00	Protected	Fished	7.0
UF29	12.66156	-61.4023	1391670.89	673565.30	2	0	2	480	0.048	41.67	0.00	41.67	Protected	No_fished	13.4
UF33	12.57764	-61.4117	1398249.50	672498.31	32	31	1	120	0.012	20.83	645.83	666.67	Not_protected	No_fished	11.8
UF34	12.61903	-61.3296	1396930.65	681432.83	2	0	2	144	0.0144	41.67	0.00	41.67	Protected	No_fished	7.7
UF35	12.59202	-61.4141	1393033.36	672271.78	1	1	0	480	0.048	0.00	20.83	20.83	Not_protected	No_fished	17.8

UF37	12.59111	-61.3764	1397604.06	676342.86	8	1	7	324	0.0324	145.83	20.83	166.67	Protected	No_fished	21.0
UF39	12.6544	-61.3891	1400248.57	674946.71	2	2	0	480	0.048	0.00	41.67	41.67	Protected	Fished	10.7
UP03	12.63758	-61.3995	1399449.15	673813.28	3	1	2	480	0.048	41.67	20.83	62.50	Protected	Fished	9.6
UP05	12.65042	-61.4002	1399008.82	673740.08	2	2	0	480	0.048	0.00	41.67	41.67	Protected	Fished	12.5
UP06	12.631	-61.3786	1392039.99	676129.05	1	1	0	480	0.048	0.00	20.83	20.83	Not_protected	No_fished	4.1
UP07	12.6178	-61.388	1391608.33	675112.11	5	4	1	480	0.048	20.83	83.33	104.17	Not_protected	No_fished	18.2
UP09	12.64685	-61.3247	1397264.19	681959.34	4	1	3	480	0.048	62.50	20.83	83.33	Protected	No_fished	10.6
UP11	12.58729	-61.3689	1399155.02	677145.39	2	0	2	480	0.048	41.67	0.00	41.67	Protected	No_fished	16.7
UP12	12.64498	-61.4021	1392547.70	673574.27	0	0	0	480	0.048	0.00	0.00	0.00	Protected	Fished	12.4
UP13	12.6312	-61.378	1396874.81	676165.94	3	3	0	432	0.0432	0.00	62.50	62.50	Protected	No_fished	12.2
UP14	12.61208	-61.3876	1392840.40	675147.53	0	0	0	480	0.048	0.00	0.00	0.00	Not_protected	No_fished	3.7
UP15	12.59458	-61.4481	1390740.79	668592.14	1	0	1	480	0.048	20.83	0.00	20.83	Not_protected	Fished	12.2
UP17	12.65513	-61.379	1400569.47	676040.10	7	7	0	360	0.036	0.00	145.83	145.83	Protected	No_fished	9.0
UP18	12.5841	-61.3602	1397375.69	678104.73	4	4	0	480	0.048	0.00	83.33	83.33	Protected	No_fished	6.1
UP19	12.63767	-61.3725	1399614.24	676750.17	0	0	0	480	0.048	0.00	0.00	0.00	Protected	No_fished	8.0
UP20	12.60944	-61.4113	1391815.08	672582.09	13	4	9	360	0.036	187.50	83.33	270.83	Protected	No_fished	9.0
UP22	12.58345	-61.4612	1392208.88	667159.71	2	1	1	480	0.048	20.83	20.83	41.67	Not_protected	Fished	13.3
UP24	12.61641	-61.4102	1391208.66	672708.01	58	57	1	240	0.024	20.83	1187.50	1208.33	Protected	No_fished	15.5
UP26	12.60356	-61.4027	1397511.38	673481.71	52	46	6	480	0.048	125.00	958.33	1083.33	Protected	Fished	11.5
UP27	12.63459	-61.4255	1391754.45	671044.99	0	0	0	480	0.048	0.00	0.00	0.00	Protected	Fished	10.7
UP28	12.582	-61.4056	1399728.64	673154.21	0	0	0	480	0.048	0.00	0.00	0.00	Protected	Fished	9.5
UP29	12.57596	-61.3947	1392934.49	674383.31	1	1	0	480	0.048	0.00	20.83	20.83	Not_protected	Fished	20.0
UP32	12.63708	-61.4016	1398406.31	673595.58	22	16	6	480	0.048	125.00	333.33	458.33	Protected	Fished	4.6
UP34	12.6055	-61.4315	1394747.52	670364.78	25	22	3	240	0.024	62.50	458.33	520.83	Not_protected	No_fished	19.8
UP36	12.59005	-61.3713	1397617.23	676897.89	0	0	0	480	0.048	0.00	0.00	0.00	Protected	No_fished	1.8
UP39	12.60576	-61.3903	1397263.88	674831.94	3	2	1	240	0.024	20.83	41.67	62.50	Protected	No_fished	14.5
UP40	12.6644	-61.44	1391414.00	669466.00	1	0	1	480	0.048	20.83	0.00	20.83	Protected	No_fished	13.1

Annex IV.2: Mock Survey Dive Safety Plan

Dive Safety Plan for the Queen Conch Abundance Underwater Visual Census in the Southern Grenadines

Introduction

Queen conch fisheries independent survey programs often incorporate surveys conducted by SCUBA divers. Because of the inherent risks associated with these activities, diver safety must be incorporated in the survey planning. For this reason, we include this section.

This plan was developed specifically for the surveys conducted in this training activity. A similar plan should be included in all survey programs that incorporate underwater surveys.

Description of the Diving Activities

The diving activities to be conducted are part of a training aimed to strengthening fisheries management program which will benefit the Caribbean Regional Fisheries Mechanism within the CARIFORUM countries. As part of the program ACP Fish II, a European Union funded initiative, the project entitled "Training in Underwater Visual Survey Methods for Evaluating the Status of *Strombus gigas* Queen Conch Stocks" was contracted to the Société Française de Réalisation d'Études et de Conseil (SOFRECO).

The overall objective of this project is to build the capacity of fisheries officers and others with similar responsibilities in the target group in using underwater visual survey methods for the management of *Strombus gigas*, queen conch. It is expected that participants will learn in detail how to use fisheries independent approaches for assessment of queen conch populations by participating in field work and conducting data analyses.

During this survey, an area of approximately 166km^2 around Union, the Tobago Cays, Mayreau, and Palm or Prune Islands in St. Vincent and the Grenadines will be surveyed by 14 divers. All divers are from the Eastern Caribbean and work either as resource managers or as fishermen, or both. At least 6 out of the 14 divers are familiarized with the local area.

Diving will be conducted on sites primarily over sandy areas since this is the preferred queen conch, but sites with gravel and corals will be also sampled. Clifton village, in the northeast side of Union Island, will be the home port, where divers will departure and return on a daily basis. The sites are relatively close to Union Island (maximum distance will be around 6 nautical miles) (Figure 1).

Approximately 60 locations will be surveyed with this group. At each site a pair of divers will count and measure all queen conch and will take underwater pictures. These activities are expected to be completed within 30min – 40 min bottom time depending on the abundance of queen conch. Transects will be 30m long and 4m wide (2m on each side of the transect line), and up to 4 transects will be conducted at each site.

One diver will secure a 30-m tape to a weight affixed to the origin of the tape. They will then swim in the direction opposite of the current depth profile permitting while deploying the 30m tape. The second diver in the team will follow the first diver and this diver will be taking the measurements and the counting. The diver conducting the survey will use a 1m PVC pole to measure 2m from the tape. All conch encountered will be measure for siphonal length and lip-thickness. When the surveying diver reaches the end of the tape, the divers will switch roles; the diver who had deployed the tape will conduct the data collection and the other diver will rewind the tape. When both divers reach the origin, the same process will be conducted going in the opposite direction. The first two transects will be on opposite compass headings, whereas subsequent transects will be at right angles to the original transects. Together, these four transects will form a cross pattern. Because of time constraints, a maximum of 4 transects will be conducted at each site.

Depth of each transect will be recorded with a depth/temperature Sensus sensor as will the GPS-WASS coordinates at the origin of the transect. Divers will carry a surface buoy so that the boat driver can follow the buoy as well as the bubbles from the divers. Divers will also carry a safety ‘sausage to facilitate locating divers in case they get separated from the dive vessel.

The diving will take place during August 9-17, 2013 and using boats, and facilities from the Grenadines dive (http://www.grenadinesdive.com/) an operation that has already valid insurances for navigation and for all recreational dive activities. Because in our case, the main objective is scientific diving, we are in need to purchase an additional insurance. Therefore, the project purchased dive insurances for those individuals not having a valid one to cover them in case of any dive accident/injury.

The local dive operator is native from the Grenadines, he knows the entire area to be surveyed, and manage a successful diving activities and business during more than 20 years. The dive program has been set up to operate out of two boats (29 and 23ft long), which have been working in the diving business, carry an oxygen kit, and a dive master to supervise the entire dive operation.

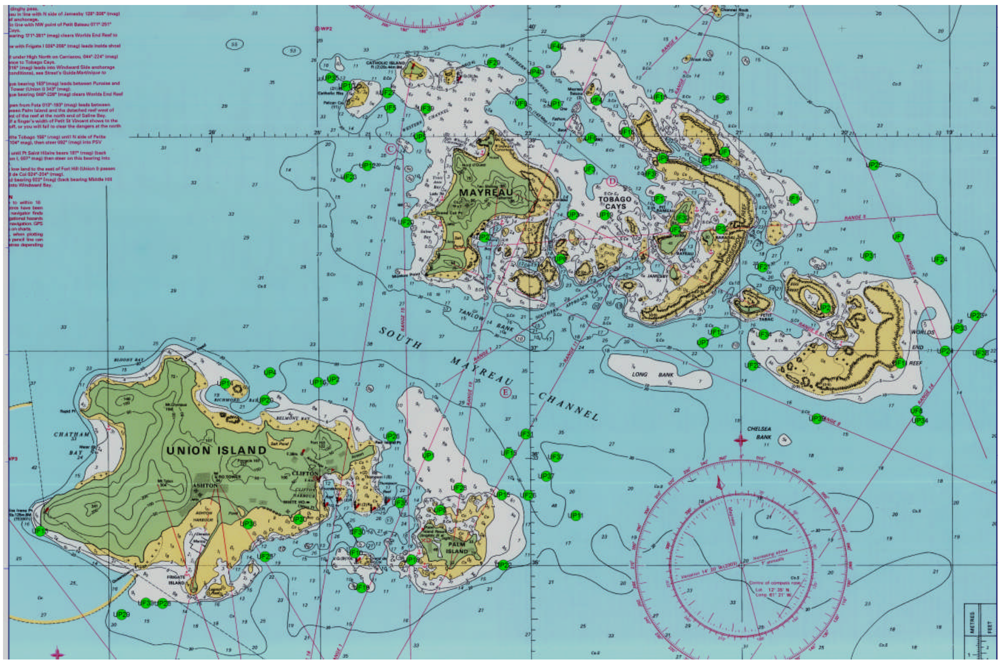


Figure 1. Area to be surveyed by diving in Southern the Grenadines. Background map is the Central Grenadines British Nautical Chart 794P available at the MARSIS geo-database (http://www.grenadinesmarsis.com/.)

Diving Safety Protocols

For the purposes of this project, a total of five dive teams will be organized. All efforts will be made to construct these teams so that one experienced and one less experienced diver will comprise the team. Two divers per team will be conducted daily. The first dive will be the deepest and will not exceed 25 m. The second dive of the day will be shallow and will not exceed 18 m. The first dive will be conducted in the morning and the second dive will be completed in the afternoon. The dives will be split by a lunch break to allow for sufficient surface interval to ensure safe diving.

In all cases, a safety stop will be conducted between 10 and 20 ft for 3 minutes prior to surfacing. Divers are instructed to begin surfacing when their air pressure has reached 800 psi thus ensuring 500 psi remain on surfacing.

As mentioned previously, each dive team will carry a dive flag.

Procedures in Case of a Dive Accident

In the case of an accident occurring during diving, the first procedure will be to administer oxygen. Immediately a call will be made to the Divers Alert Network to assist with evaluating the accident and making a preliminary diagnosis. The Divers Alert Network hotline is available 24/7 (1-919-684-9111) and they will facilitate arranging facilities should the diving be related to a hyperbaric incident such as decompression sickness (DCS). They can also assist in providing guidance on emergency treatment.

In all cases, Dr. Susan Singh-Renton will be immediately notified of the incident. Depending on the nature of the accident, additional authorities will be notified either for emergency transport of simply for notification. These notifications will be considered based on the incident and the severity of the incident.

Emergency Contacts – St. Vincent and the Grenadines

In case of emergency, the following agencies can be contacted. They are already informed about our working plan with regard to the diving activities:

Divers Alert Network (DAN) **Emergency Hotline (+1-919-684-9111)**

> DAN's Emergency Hotline staff members are on call 24 hours a day, 365 days a year, to provide information, assist with care coordination and evacuation assistance. This number should also be used to access DAN TravelAssist benefits and services — even when the emergency is not related to diving.

Local Contacts to be Notified in Case of an Emergency

Union Island Police Station	**Tel. 784-458-8229**
Grenadines Dive	**Tel. 784-458-8138, Cell.784-455-3822**
Union Island Health Centre	**Tel. 784-458-8245**
St. Vincent accident & emergency	**Tel. 784-456-1955**
Aircraft charters SVG Airlines	**Tel. 784-457-5777**
Dr. Susan Sing-Renton	**784-533-7621 (mobile),784- 457-3474 (landline)**
Sherril Barnwell	**784-532-5145 (mobile)**

Emergency Evacuation Locations – Hyperbaric Chambers

There are two decompression chambers with quick access to the airport at Clifton on Union Island:

1. **Barbados Defense Force Chamber** **Tel. 246-436-6185, emergency 246-427-8819**
2. **St Lucia Hyperbaric Chamber** Tel. 758 456 0415

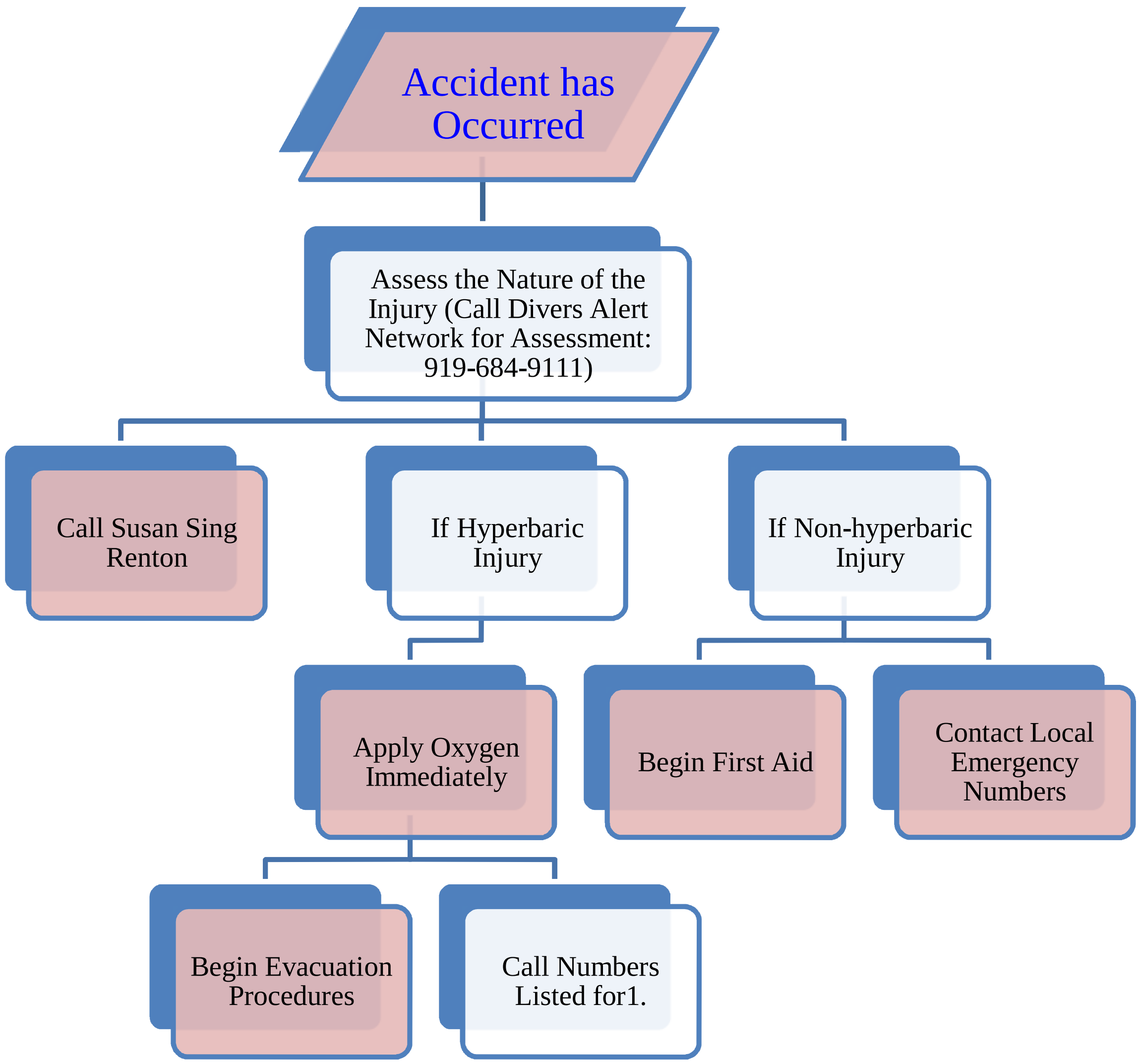
The following hospital and individuals are associated with the St. Lucia Hyperbaric Chamber and should be contacted immediately in case of a diving emergency:

Tapion Hospital ER: 758 459 2617, 758 4520005, 758 459 2000

Dr G. Melville: 758 459 0620, 758 720 0621

Mr. Curtis John: 758 712 8858

Procedures in Case of Dive Emergency



Annex 1. Divers and their dive certification information who are participating in the conch surveys in the waters associated with Union Island, St. Vincent and the Grenadines from 9 August 2013 through 21 August 2013.

	Country	Name	Certifying agency	Level	ID number
1	Antigua	Hilroy SIMON	PADI	open water	1205013925
2	Bahamas	Jeremie SAUNDERS	PADI	open water	87173940
3	Belize	Marsha VARGAS	PADI	open water	11043984
4	Dominican Republic	Elodie FERNANDEZ	PADI	advance/nitrox	
5	Grenada	Olando HARVEY	PADI	advance	13060T5617
6	Haiti	Jean Christin HENRY			
7	Jamaica	Ricardo MORRIS	PADI	open water	91109714
8	St. Kitts	Shawn ISLES	PADI	open water	712036796
9	St. Lucia	Sarita WILLIAMS-PETER	PADI	open water	93010204
10	Union Island	Albert HANSON	NAUI	open water	602011710
11	St. Vincent	Lucine EDWARDS	BSAC	ocean diver	A762314/1265
12	St. Vincent	Kris ISSACS	PADI	open water	310039114
13	Colombia	Martha Prada	NAUI/PADI	advance/ nitrox	5879/ 306103018
14	USA	Robert Glazer	IANTD/PADI	advance/ nitrox	3322/ 83348310

Annex 2. Emergency contact information for divers participating in the queen conch surveys in the waters associated with Union Island, St. Vincent and the Grenadines from 9 August 2013 through 21 August 2013.

Participant	Emergency	Address	Mobile	Home	Work	e-mail
Hilroy SIMON	Shecore Simon	Morris Extension, Old Road Road Village, St. Mary's Parish	1 268-723-9013	1 268 460 9375	1-268-480-7176	
Jeremie SAUNDERS	Carla Saunders	Marsh Harbour, Abaco Bahamas P.O.Box AB 20384	1 242-475-2387	1 242 367 4445		jeremysaunders@bahamas.gov.bs
Marsha VARGAS	Sherol Bethran	19 miles Sand Hill Village Belize District Phillip Goldson Highway	1-501-668-4850	1-501-205-5089	1-501-224-4552	
Elodie FERNANDEZ	Patricia de Robillard	Fica Cambero, La Ceiba, Las Terrenas	1-809-914-6909			patriciaderobillard@hotmail.com
Ricardo MORRIS	Marcia Morris, Mother	1227 E223rd Street, Bronx , New York, NY		1-347-780-8322		
Orlando HARVEY	Ann Harvey (Mother)	Ashton, Union Island, St. Vincent		784 458 8769		
Sarita WILLIAMS-PETER	Cynthia Labadie; Richard Shorn Peter	c/o Department of Fisheries, Sans Souci, Castries , SLU; Husband: Bonne Terre, Gros Islet Castries	1-758-715-8282	1-758-720-8172; 1-758-721-8256	1-758-468-4142; 1-758-450-3039	
Lucine EDWARDS	Maurice Edwards	Belair P.O., Belair	1-784-528-0114	1-784-456-4136	1-784-456-1667	
Shawn Isles	Latasha Isles	Bath Village Charlestown Nevis	1 869-665 -6400	1-869-763-1182	1-869-469-5521	fisheries@niagov.com
Bob Glazer	Merlou Robinson (wife)	591 Sombrero Beach Rd #3 Marathon, FL USA 33050	1-785-766-6296			merlou_r@yahoo.com
Kris Isaacs	Pearlina Isaacs	Biabou, St.Vincent	1-784-491-6313	1-784 458-0754		
Jean Christin HENRY	Menel HENRY	Fontamara 27 Port Au Prince, Haiti	1-509-373-42592			
Martha Prada	Jose A. Rivera	Urb. Fair View, Calle Diego Morguey No. 18-74, San Juan, PR 00926	1-787-501-7639			jarivera@msn.com
Albert HANSON	Viviette Mattheus	Clifton Union Island	5304703			

Annex 3. Example of dive insurances purchased for the mock survey

Travel Voucher
Traveler EMS Credentials

Traveler EMS Prepared Diver Program

This document will certify that the individual identified herein is enrolled in the Traveler EMS program indicated below:

Name (Last, First, Middle):	HANSON, ALBERT
Home Address:	Clifton Union Island St. Vincent & the Grenadines 0000 St. Vincent Kingston, Jamaica 0000 Jamaica
Date of Birth:	19 July 1972
Telephone:	530.4703
Traveler EMS Program:	Prepared Diver Program
Benefit Limits:	US$125,000
Traveler EMS Expiration:	31 August 2014
DAN World / TEMS Client #:	6007562

See Detailed Description of Benefits for Prepared Diver Program for detailed description of benefits, limitations and conditions. Refer to www.DANWorld.ky for more details.

This is a dive accident and travel assistance plan with worldwide benefits provided by Traveler Emergency Medical Services, Ltd. (Traveler EMS). Traveler EMS must be notified immediately if the event of an accident. Limitations and special exclusions may apply. This program provides benefits for dive accidents anywhere in the world, regardless of the depth of the dive.

In the event of a dive or medical emergency, please render assistance as necessary and contact local emergency medical services. It is also necessary to contact DAN Emergency Services in the U.S. at: +1.919.684.9111 (collect calls accepted). When answered, say that you are calling for emergency assistance.

MEMBER CARD
Prepared Diver Program

MEMBER	**Hanson, Albert**
DAN WORLD#	**6007562**
EXPIRATION	**31 August 2014**
LIMITS	**US$125,000**

www.DANWorld.ky

DIVING EMERGENCIES
+1.919.684.9111

EMERGENCY TELEPHONE NUMBERS

Main Emergency Hotline for DAN World members

Divers Alert Network
+1.919.684.9111
accepts collect calls

For General Inquiries about Benefits (non-emergency)

English:	+1.202.470.0929
Spanish:	+52.55.8421.9866

Other DAN Diving Emergency Hotlines

DAN Europe
+39.06.4211.8685

DAN Japan
+81.3.3812.4999

DES Australia
1.800.088.200 (within Australia)
+61.8.8212.9242 (outside Australia)

DAN Asia-Pacific - Philippines
(02) 632.1077

DAN / DES New Zealand
0800.4DES111
Singapore Naval Medicine & Hyperbaric Center
6758.1733

DAN Asia-Pacific - Malaysia
(05) 681.9485
DAN Asia-Pacific - Korea
(010) 4500.9113
DAN Asia-Pacific - China
+852.3611.7326

DAN Southern Africa
0800.020.111
(within South Africa)
+27.10.209.8112
(outside South Africa)
accepts collect calls

Annex IV.3: List of Presentations Given During Classroom Activities

Annex V. List of Power Point Presentations developed

Conservation Policies

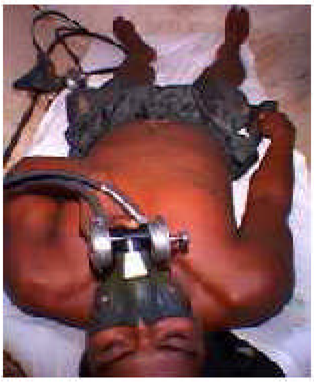
Training in underwater visual survey methods to evaluationg the status of *Strombus gigas*, queen conch Stocks

St. Vincent & the Grenadines, August 2013

SOFRECO

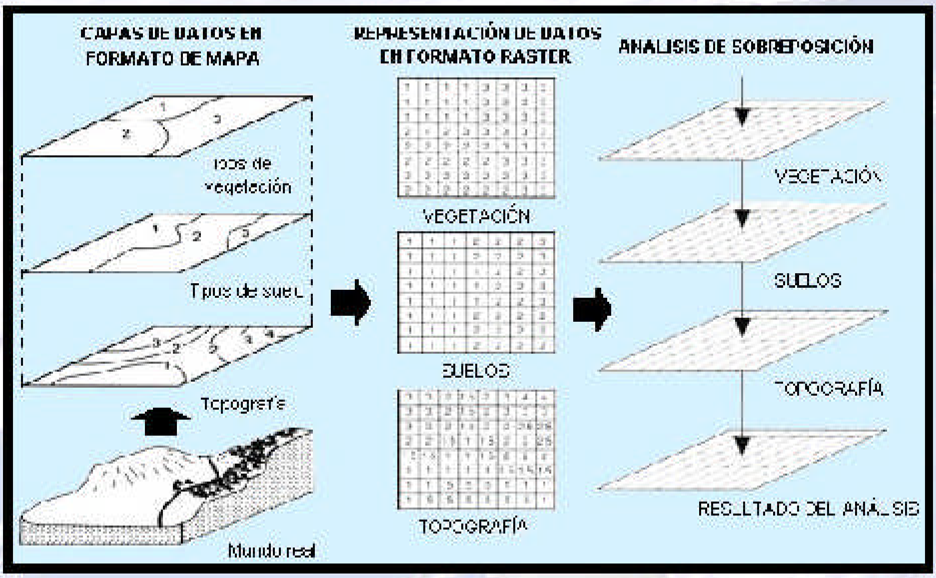

Queen Conch Fishery
in Belize
A short overview
Marsha Vargas

Dive Safety



Bob Glazer

GIS...What for?


CAPAS DE DATOS EN FORMATO DE MAPA
REPRESENTACIÓN DE DATOS EN FORMATO RASTER
ANALISIS DE SOBREPOSICIÓN
VEGETACIÓN
SUELOS
TOPOGRAFÍA
Mundo real

Introduction to GIS and geospatial data management

Gerardo Rios Saís

Google Earth Outreach Training

Workbook for Indigenous Mapping Workshop

The workbook is a companion to the *Indigenous Mapping Network – Google Tribal Geo Tech Workshop*, to guide you through the demonstrations and exercises during the workshop, and as a resource for further self-paced training in the future for yourself and your entire community or organization.

Download all data for this workbook here:
http://sites.google.com/site/imnworkshop/data-for-workshop/data.zip

Important Links:
Main Workshop Site: http://sites.google.com/site/imnworkshop
Indigenous Mapping Network: http://indigenousmapping.net
Google Earth Outreach: http://earth.google.com/outreach
Google Geo Developers: http://code.google.com/more/#google-geo

The Importance of Habitat Monitoring in Queen Conch Fisheries Independent Sampling

Bob Glazer

Lambi Early life

Training in underwater visual survey methods to evaluationg the status of *Strombus gigas*, queen conch Stocks

St. Vincent & the Grenadines, August 2013

SOFRECO

Lambi (*Strombus gigas*) Life Cycle

Training in underwater visual survey methods to evaluationg the status of *Strombus gigas*, queen conch Stocks

St. Vincent & the Grenadines, August 2013

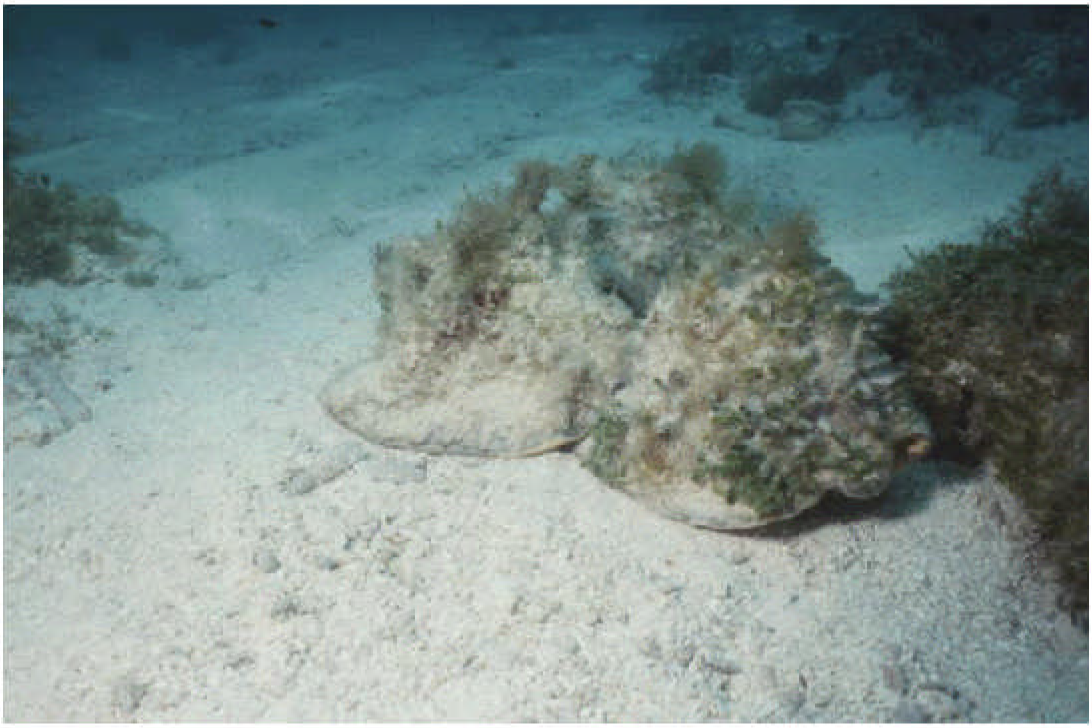
SOFRECO

Populations and Connectivity
Session 3

Bob Glazer


Training in Underwater Visual Survey Methods for Evaluating the Status of Queen Conch Stocks
Martha Prada and Bob Glazer
St. Vincent, June, 2013
CRFM
ACP Fish II
SOFRECO

Conch Reproduction



Bob Glazer

Lambi (*Strombus gigas*) Shallow water surveys

Training in underwater visual survey methods to evaluationg the status of *Strombus gigas*, queen conch Stocks

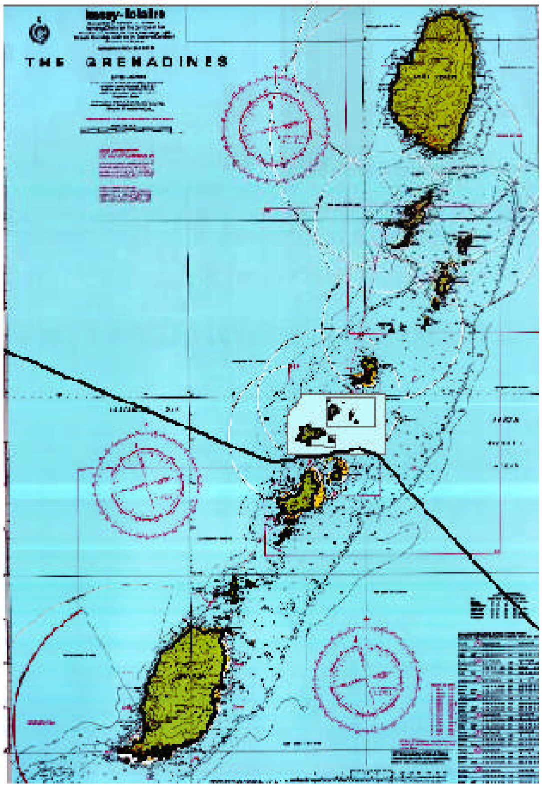
St. Vincent & the Grenadines, August 2013

SOFRECO

Shallow-water transects for Queen Conch Aggregation Monitoring

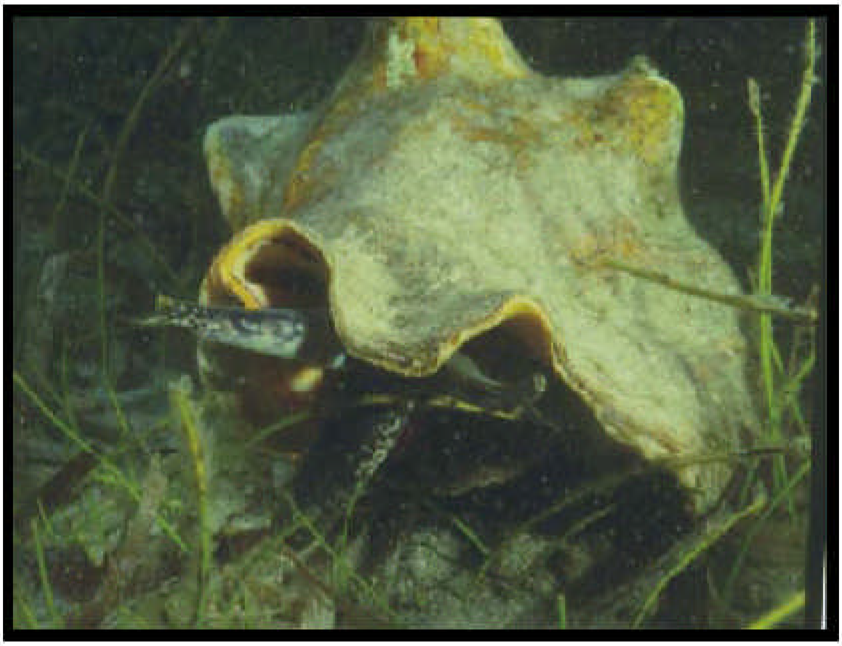
Robert Glazer


Data SIO, NOAA, U.S. Nav


THE GRENADINES


Training in Underwater Visual Survey Methods for Evaluating the Status of Queen Conch Stocks
Project ref. N° CAR/3.2/B.14
Martha Prada and Bob Glazer
Region: Caribbean – CRFM member states
Country: St.. Vincent & the Grenadines
June – August, 2013
ACPFish II
SOFRECO

Queen Conch Early Life History



Robert Glazer

Annex IV.4: Countries-Specific Plans for Queen Conch Fisheries Independent Surveys

ANNEX VII. Country Specific Plans

Country: Jamaica

Proposal: Assessment of Jamaican Queen Conch (*Strombus gigas*) deep (below 30 metres) stocks on the Pedro Bank
Prepared by: Ricardo A. Morris, Fisheries Officer
Institution: Fisheries Division, Ministry of Agriculture and Fisheries, P.O. Box 470, Marcus Garvey Drive, Kingston 13, Jamaica.

Background

The Queen Conch (*Strombus gigas*) is Jamaica's most important fishery resource providing over US$4 million in gross export revenue annually from supplying primarily the EU (European Union) market with an average 500 MT of meat over the last decade. Its importance extends also to the provision of jobs at various levels from fishing, harvesting, processing to the exportation of the product. Sustainablity and continued development of the resource is therefore the most important strategic objective of Jamaican fisheries managers.

Project Rationale/Problem Statement

Jamaica since 1994 Jamaica has put in place a programme of conducting conch abundance surveys on the Pedro Bank every three (3) to five (5) years to (i) assess the stocks there for the industrial fishery and (ii) as partial partial fulfilment of Jamaica's obligation under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to present non-detrimental findings (NDF) and (iii) to assess the state of the conch habitat. These are important facets of our management regime aim at sustainable development of this our most valued fishery resource.

To date we have completed five (5) such surveys on the bank down to 30 metres however it has long been report anecdotally and otherwise that there may be large protected spawning aggregations of conch below this depth particularly on the north-eastern and north-western reaches of the bank. We believe that confirmation and ultimately a strategic assessment plan for this deeper area will allow for a more wholesome picture of the state and extent of queen conch on the Pedro Bank allowing for even more informed management measures to be implemented.

We have been unable thus far to assess these deeper stocks due main to (i) diver safety concerns, (ii) the availability of digital bathymetry information on the bank to assist with planning and carrying out of such assessments, (iii) lack of an accessible and cost-effective method of assessment, and (iv) and a general lack of human, technical and financial resources.

Goal

Assess the deep-water (>30 metres) Queen Conch (*Strombus gigas*) stocks on the Pedro Bank using appropriate assessment methods.

Objectives

1. Confirm the existence of deep-water aggregations of conch in deep-water zones of the Pedro Bank
2. Determine a baseline for the size, distribution and structure of deep-water aggregations on the Pedro Bank
3. Explore, assess and compare the effectiveness of using underwater cameras for deep-water survey of conch on the Pedro Bank

Availability of Resources

Data

There is fairly good quality data on the current state of Jamaica's conch fishery especially since 1994 however this information represents catch and effort from fishing in areas below 30 metres. Fishing does not occur in areas below 30m depth. Apart from depth and basic habitat information available from nautical charts there is very little information on the deeper areas of the bank.

Marine personnel and Equipment

If required the Fisheries Division does have a cadre of persons who are able to be at sea. There are 2 persons with boat-handling competence and at least 6 persons on staff who are certified divers, however since the focus of the assessment will be on using cameras to assess depths below 30 metres we would not expect divers to play a big role. Their importance may be in, for example, the analysis of underwater pictures and videos.

In terms of equipment we have available one **27 feet Boston Whaler** that may be used to transport persons and equipment, one **21 feet inflatable boat** with less capacity but can provide support, as well as **dive gear** and **30 tanks for 6 persons** (if required). Additionally we have 2 Trimble Explorer GPS units however lacking a reliable operating software.

Proposed Survey Area

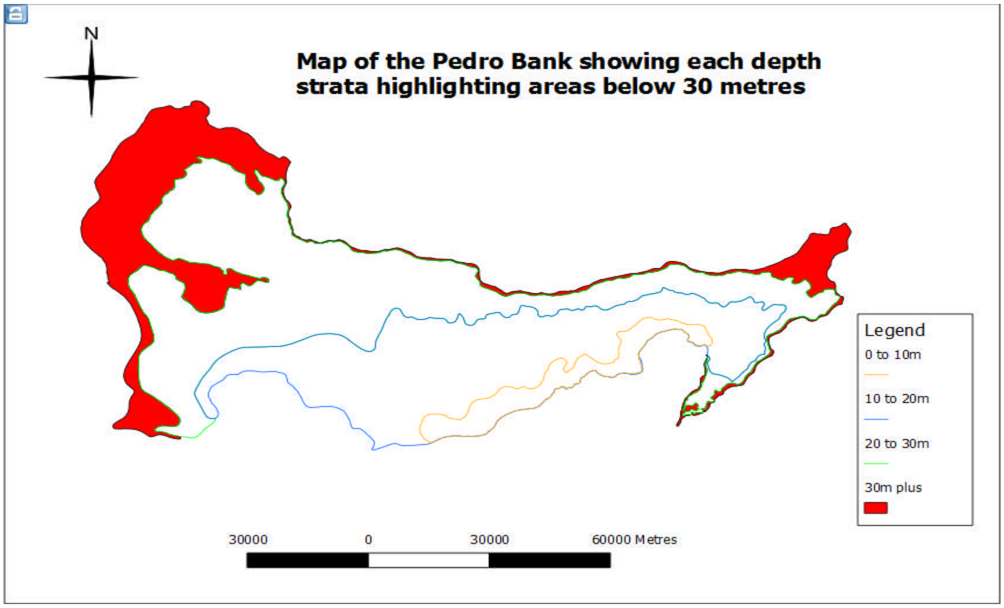


Figure 1. Pedro Bank depth strata highlighting the deep-water zone (below 30 m).

The programme of surveys since 1994 has been focused on areas of depths down to 30 metres. The proposed assessment would be conducted at the north-western and north-eastern reaches of the bank depths below 30 metres where it is believed there may be protected deep spawning populations. This zone covers an area approximately **1,617.21 km²** and has mixed depths down to about 60 metres.

Proposed Method

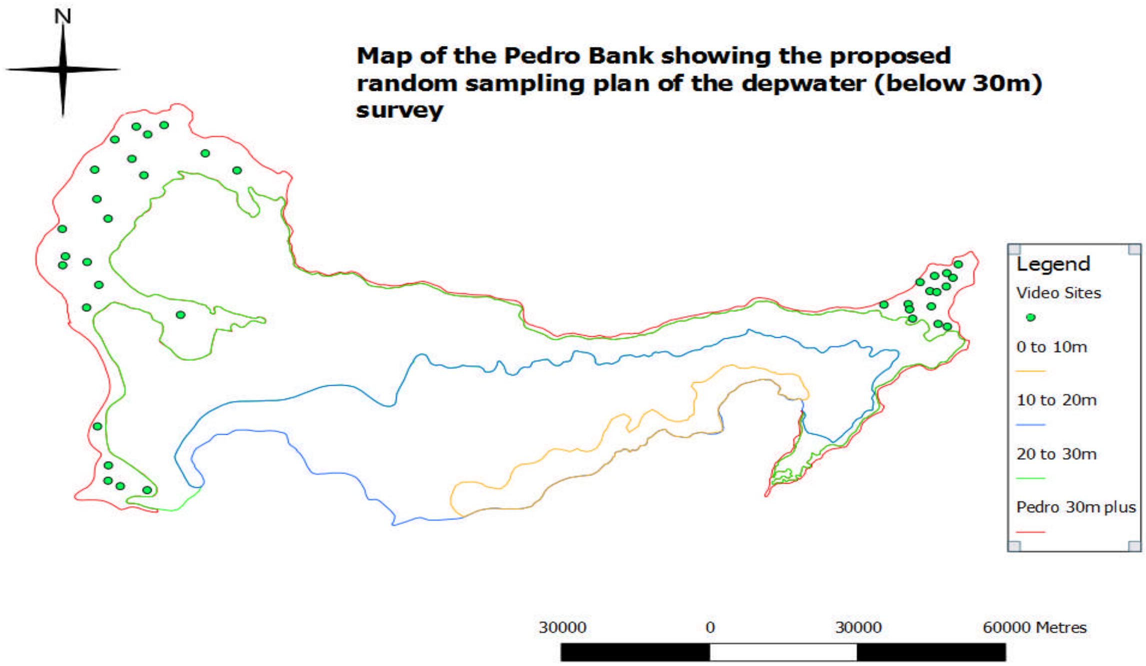


Figure 2. Map shows the proposed sampling plan 38 sampling stations for both video transects and enriched for surveying the deep-water areas of the Pedro Bank.

The survey plan includes the completion of thirty-eight (38) 5 to 10 minute video transects across the deep zone using a SEAVIEWER underwater video camera or an appropriate alternative to ascertain the location, distribution, size, population structure, and the associated habitat of conch in the deep zone. Video recordings as well as written notes on habitat type, habitat condition, temperature, depth, and additional comments will be recorded and stored on a field rugged laptop and backed-up on and external hard drive for analysis back on the mainland.

The survey would be conducted using the 2 available vessels operating from the Pedro Cays for roughly 5 survey days with 2 additional days for travelling to and from the mainland. Baring in mind that the Pedro Bank lay some 70km south of the mainland it would not be practical to do daily trips from the mainland and so an addition support vessel may be required to transport equipment and supplies to the cays.

On the collection of all transect data and return to the mainland analysis will be conducted over and approximate period of 10 days by fisheries biologists and fishers who will visually analyse the video content and written to generate a final report.

Resources and Draft Budget

ITEM	QUANTITY	PURPOSE	ESTIMATED COST ($US)
Sea Viewer underwater camera with fixtures for operating down to 70m	2	Underwater visual survey	14,000
GPS Mapping software for Thrimble GPS – geoexplorer 2008 Series	1	Planning and Mapping	1,500
Field rugged laptop computer and external hard drive	1	Storage and analysis of data before during and after survey	3,500
Training in the use of Nitrox mixes for scuba diving	6	Deep-water diver surveys	20,000
Nitro scuba tanks and dive computers	6	Supply and regulate nitrox levels	
Full-face mask with seafloor-surface communication unit	4	Communication between diver and boat	3,000
Picture analysing software	1	Analysis of picture and video images	2,500

Timeline

Given the objectives listed above the entire survey including planning, mobilization of personnel and equipment to the base on the Pedro Cays, collection of underwater video data, collection of data, through to analyses and final report should take roughly **20 days** to complete barring any undue delay.

Country: Belize

Proposal: Deep water conch (*Strombus gigas*) habitat and potential reproductive grounds
Prepared by: Marsha Vargas, Assistant Fisheries Officer
Institution: Belize Fisheries Department, Princess Margaret Drive, P.O. Box 48, Belize City.

Background

In the last ten years the Belizean Queen Conch fishery has remained more or less stable with the recommendations made through the National surveys and analysis of those surveys. sustainable quotas have been established each year and the cooperation of the fishers, cooperatives and other stakeholders also add to this success.
With the Queen Conch being on the CITES appendix II since 1992 and The Belize Fisheries Department conducting National abundance surveys since 2003; the next step to a more productive and sustainable Conch Fishery would be assessing the reproductive stocks.

Objectives

To conduct survey to determine deep water queen conch replenishment stocks in Belize.

Specific objectives:

- To assess the abundance of deep water Queen Conch stocks in Belize.
- To identify deep areas with high Queen Conch aggregations.
- To collect data identifying deep conch stocks such as: shell length, lip thickness, depth found, habitat and whether or not mating and or egg laying is occurring.
- To assess the maturity levels of the deep conch stocks.

Methods

Surveys will be conducted at the fore-reef of each marine reserve. These sites will be surveyed using the line transect method. These transects will be 30 meters long by 4 meters wide and 30 meters apart. The same strategy will be used within channels and deeper general use areas.

Morphometric data collection:

1. Shell length (SL) (tip of the spire to the siphonal canal) will be measured to the nearest millimeter using a measuring board/ruler.
2. The shell lip thickness (LT) (mid-lateral region on the lip flared side of the shell/the flared area in line with the larger shell spike) will be measured to the nearest 0.1 mm using sliding vernier calipers.
3. Life stage of conch will also be Identified
4. Data will be digitized by individual data collectors in a coordinated method.

Example of field data sheet for queen conch data collection:

Date:	Transect No:	GPS		Depth (ft)	Habitat Type	No. conch	SL (mm)	LT (mm)	Conch aggregations	
Comments										

The survey is proposed to explore:

Northern Belize: Bachalar Chico, Hol Chan and Caye Caulker Marine Reserves.
Central Belize: Turneffe MR and Half Moon Caye MR
Southern Belize: Glovers Reef MR, South Water Caye MR, Sapodilla Caye MR, Port Honduras MR and Gladden Spit area.

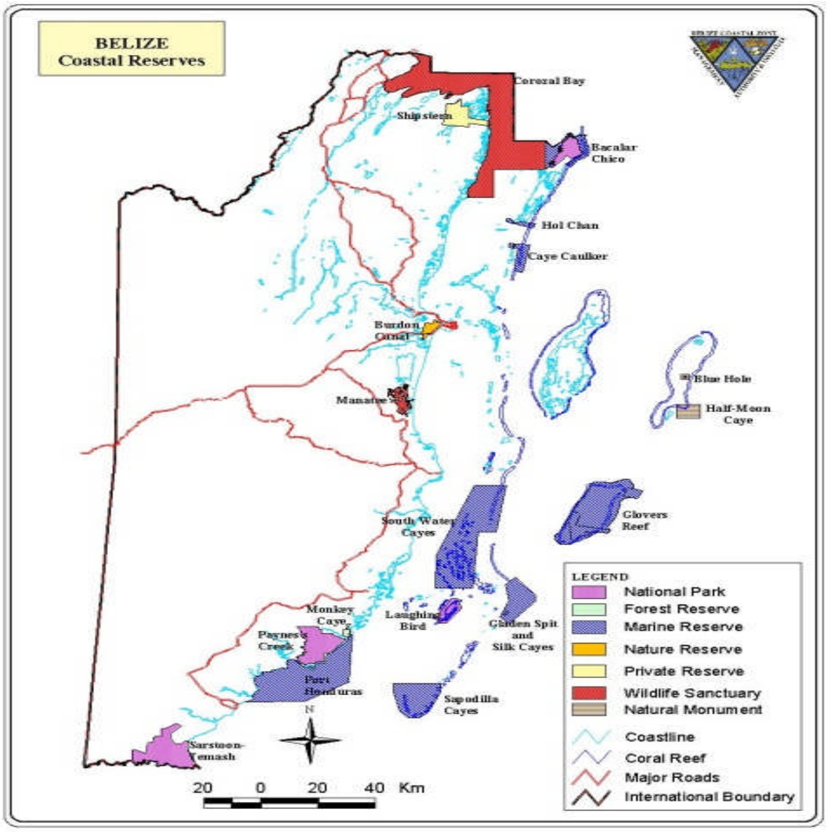
The deep areas reaching 70 - 90 feet outside the atolls of these reserves, within the channel areas and other deep water areas should be focused on.

The number of sites to be surveyed is not absolute but estimated to at least 35 sites nationally.

Team members:

Northern Teams	**Central Teams**	**Southern Teams**
2 divers Bachalar Chico	Joel Cruz	2 divers Glovers Reef
4 divers Hol Chan	Dwayne Garcia	2 divers Port Honduras
2 divers Caye Caulker	Mark Gentle	2 divers Sapadilla cayes
	Eli Montejo	
	Sherwin Pirerra	
	Michael Sabal	
	Marsha Vargas	
Additional divers may be taken from the central team to assist some of the northern sites.	Dive Masters from the Northern team's Hol Chan may be assisting the Central and Southern teams.	Additional divers from the Central Team and Dive masters from Hol Chan may assist the Southern Teams

Equipment and materials: in addition to the equipments and materials needed at least 8 Fisheries department vessels will be utilized.



Estimated budget (in Belize dollars)

ITEM	Cost	# of Items	Total cost
Dive equipment	$ 400.00	6	$3200
slates	$200.00	N/A	$200
100 m tape	$50	6	$300
calipers	$5	20	$100.
Calibrated rulers	$20	10	$200
Data sheets	$10	3	$30
Tape	$15	2	$30
pencils	$5	6	$30
rope	$3	2000 ft	$5000
Fuel	$12	4000 gal	$48,000
Oxygen refill	$5	35 dives	$ 175
First aid kits	$250	6	$1500
Advisors	$5000	1	$5000
TOTAL			**$63,840**

Sources of funding:

1. Government
2. NGO

3. Cooperatives
4. Other interested stakeholders

Funding needed for equipment, fuel, subsistence, other incidental costs and funding needed for outside professional input/advisor.

Time table (Scheduled 2013 – 2014)

Duties	October	November	December	January	February	March	April	May	June
PR	X	X						X	X
Staff	X	X							
Funding	X	X	X	X	X			X	X
N. survey			X	X	X				
C. Survey			X	X	X				
S. Survey			X	X	X				
Data compilation						X	X		
Data analysis and results								X	X

Recommendations:

- In order to find possible aggregations without sending divers in the water each time the use of an underwater video camera may be utilized. By towing the video camera linked to a cord, screen and apparatus then towing it along the water column observers can perhaps spot conch.
- The whole DVR set up, underwater cam, screen, cords, PVC set up, GPS, GPS USB connecting cable, 'modem' to link underwater cam and screen and GPS would cost around $6000. US dollars. The set back would be need for training for proper use and set up the equipment.
- Conch stocks around the Caribbean are believed to be interrelated and so it could be an advantage to invite other regional countries to observe and participate in the deepwater data collection. National Plan of action with regional support.

Country: Dominican Republic

Proposal: Queen conch (*Strombus gigas*) survbey in Dominican Republic
Prepared by: Elodie Fernandez, Research assisant
Institution: Dominican Council for Fisheries and Aquaculture, Urb. Jardine del Norte Km. 61/2 Autopista Duarte, Santo Domingo
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Problem statement

Several Queen Conch abundance studies have been carried out in the Dominican Republic, however, there is not still enough information to determine a fishing quota to allow exportation, which was banned in 2003 by CITES recommendation. Deeper areas (below 20m) are the least known related to Queen Conch density due to limiting bottom time from scuba diving with normal air. In addition, there are still some marine protected areas where Queen Conch fishing occurs but a distribution or population size study has never been carried out. This is the case of the North coast of Samaná Peninsula.

Objectives

The main objective of this study would be to cover the areas not included in the new Conch Survey funded by FONDOCYT and managed by the Autonomic University of Santo Domingo (UASD), based on the Assessment of Queen Conch population in two protected areas in the Dominican Republic: Parque nacional Jaragua and Parque Nacional Montecristi. This study objective would be to assess the Queen Conch population size also in the marine protected area in the North coast of Samaná Peninsula. The combination of results could mainly help to establish the first and more precise sustainable quota system to finally lift the exportation ban and allow the country to profit at the maximum its resources, while maintaining the sustainability. In addition, this study could bring the possibility of developing deepwater surveys using new methodologies, like underwater visual camera. Finally, it would be very important to try to establish a national data collection program at least in the most important fishing areas.

Availability of resources

a. Data about the fishery in terms of captures and fishing effort (current and historical).

In the last 30 years, Queen Conch production has increased substantially due to an increase in the export market demand, an increase in the national population and an increase in tourism. Studies undertaken in the country for the moment suggest that national Queen Conch populations have not been permanently impacted due to overfishing. However, some recent studies (not published yet) indicate a density of 11.5 individuals/ha in PNJ, a main fishing area, when 56 individuals/h are needed for reproduction to take place. More studies are needed nationally about population status and commercialization.

b. Dive support, certified divers, diving gears, boats, etc.

Samaná is characterized by a large number of free and scuba divers. However, this does not mean that all scuba divers are correctly certified. The availability of boats for renting should not cause a major problem in the Peninsula. Diving gears are available in several diving center in Samaná.

4. Proposed methods/sampling plan

Before initiating any field work, all types of images available will be obtained and studied for the study area, from maps to aerial photographs and GIS data. Using this material, the survey area will be determined and delimited. No study has ever done before in this area, therefore, no comparison or baseline is available about specific areas to be sampled. Some maps of habitat zonation were recently made for Samaná Peninsula, which could help to first determine the habitats where conchs are more prone to be found. Once areas and stations are randomly selected, the locations' coordinates will be introduced in the GPS available for the study.

The protected marine area in the surrounding almost all of Samaná Peninsula is known as the Sanctuary of marine mammals Silver Bank and Navidad Bank, which covers an area of 25,240km^2. This is an extremely large area, so only the closest shelf to the North coast of Samaná will be considered. To specify the distance from the coast where the sampling will take place, available data on bathymetry of the area will also be used. Equal or less than 20m depth will be considered as shallow areas, which will be surveyed with scuba diving. For deeper waters, maybe down to 45m as the deepest, underwater visual camera could be utilized. This is a fairly new methodology, so results could be unexpected and the method itself not considered a precise tool to estimate Queen Conch abundance in deeper waters. In addition, this differentiation in depth also correlates to more exploited areas (shallow waters, which fisherman can reach using compressors or snorkeling, mainly) or least exploited areas (deep waters, maybe reached only using compressors, although death risk is much higher).

Following the same methodology than the assessment on Queen Conch to be undertaken in PNJ and PNM, once determined the exact boundaries of the study area, two trips will be done yearly for two consecutive years. These will be 10 days long, one during the close season (from July 1st to October 31st) and the second during the open season (the rest of the year). This will allow to compare abundances during supposed presence or absence of fishing pressure within and between the three protected areas (PNJ, PNM and Samaná Peninsula). The exact number of stations would be determined later after the analysis of the maps, however, the total sampled area should cover 30% of the total study area determined for the assessment for it to be statistically relevant.

The preferred methodology for "shallow" waters and probably best known one in the country is the Belt Transects. In this case, transects would be 100m long, 5m wide and perpendicular to the coast (method already used in past assessments in the country, in PN del Este) to be sure that depth ranges will allow this. This will be done using scuba diving gear. While one divers runs the tape, the other two run at both sides of it covering 2.5m each. Lip thickness and siphonal length will be measured from each conch encountered. In addition, the habitat surrounding the conch will be described, any particular observation or whether any type of reproduction was observed. The rest of the shallow water methodology will be the same as for the Queen Conch assessment carried out by the UASD.

As already mentioned earlier, deeper waters (approx. 20m to 45m) could be surveyed using underwater visual camera. Already randomly determined 500m long transects, also perpendicular to the coast, will be used.

The basic analysis of the data will include the calculation of Queen Conch density per square hectare and the fishing quota for the country.

During both the field work and data analysis, fishermen participation and advise will be always included and considered extremely valuable.

Draft budget

This study would be very similar to the assessment to be done by the UASD. Therefore, the budget used to undertake such assessment should be similar for this study.

The common and main activities to be covered are the salaries for the coordinator and field assistants. In addition, to pay the field trips, the equipment needed for underwater activities (calipers, tapes, underwater photographic cameras, buoys, rope, water resistant paper, etc.), the equipment for boat activities (GPS, computer, printed maps, etc.), renting of boats and diving gear, etc.

Therefore, since we are considering only one study area in this proposed survey, the budget should be about RD$ 4,000,000 (about US$ 95,000).

Country: St. Lucia

Proposal: Assessment of Conch population in Saint Lucia
Prepared by: Sarita Williams-Peter, Fisheries Biologist III
Institution: Ministry of Agriculture, Food Production, Fisheries and Rural Development, Sans Souci, Castries.

Problem statement

The catch per unit effort abundance index for the conch fishery in Saint Lucia shows an annual continuous decline (CRFM, 2009) and fishers have been progressively fishing deeper due to the decline in availability of nearshore stocks (King-Joseph et al., 2006). There are two main concerns have been hypothesized for the decline in nearshore conch stocks – decline in suitable conch habitat and overharvesting. Currently, there is no information on island-wide conch aggregation distribution, reproductive status or habitats in Saint Lucia that will assist in the sustainable management and use of the species, extend management of the conch fishery to an ecosystem approach and strengthen the reliability of fishery dependent assessments.

Objectives

1. To determine the conch abundance and density baseline in Saint Lucia founded on both habitat and depth strata.
2. To determine the abundance conch aggregations in deep water where depth and other unfavorable conditions limit fishing.
3. To establish a total allowable conch biomass that can extracted from the fishery waters of Saint Lucia.
4. To determine interrelationship between conch aggregations and identify critical aggregations for larval production and settlement.
5. To build capacity of conch fishers in assessment of conch stocks and to develop a collaborative management strategy for monitoring of the status of conch stocks and providing landing data.

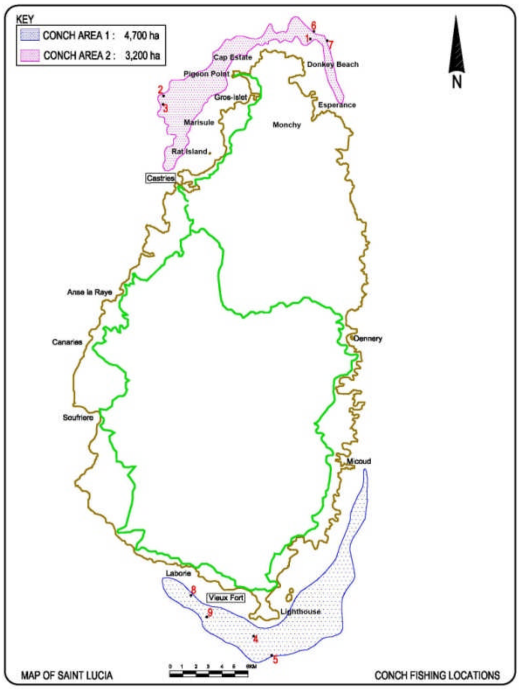
Availability of resources:

a. *Data about the fishery in terms of captures and fishing effort (current and historical).*

Catch per unit effort index for the conch fishery appears to be declining each year using the measure of effort as the number of compressed air tanks used (CRFM, 2009). Landings from over the past ten years (2002 -2012) have varied between 63mt to 28mt each year.

b. *Estimation of the area needed to be survey for depths less than 80ft and for areas between 80 and 140ft.*

Fishing primarily takes place between 80 to 140ft using self contained underwater breathing apparatus (SCUBA). There two main fishing grounds between 80 to 140ft which are approximately 4700ha in the south and 3200ha in the north (total: 7900ha). There are some reports of conch in shallower areas; however, conch fishers have reported poor coastal habitat due to siltation as a major factor for lack of conch.



c. *Digital or physical maps.*

The only habitat maps available, these are of the west coast area within the Soufriere Marine Management Area. These are within shallow depths as it was done using aerial photographs.

d. Dive support, certified divers, diving gears, boats, etc.

There are five certified PADI SCUBA divers at the Department of Fisheries:

- Open water: three (3)
- Advanced: one (1)
- Rescue: one (1)

The Department can receive dive support from various registered dive operations on island and through a few conch fishers. The Department can rent the use of a vessel and dive gear.

The Department also has vernier calipers and depth gauges.

Proposed methods/sampling plan

A taskforce will be established with key representatives from the following agencies.

1) Department of Fisheries (Lead)
2) Ministry of Planning (GIS)
3) Gros Islet Fishermen's Cooperative and the Laborie Fishermen's Cooperative (Dive assistance and collaborative plan)
4) Independent Conch Fishers (Dive assistance and collaborative plan)
5) Statistical Department (assistance with Data Analysis)

A consultation with fishers and other stakeholders on the need for conch surveys and train taskforce in conducting queen conch surveys.

GIS maps will be generated and random sampling points against various strata (depth and habitat where available) will be plotted to cover at least 30% of the sampling area. There will be two sampling teams each will comprise two dive buddy teams; a vessel, captain, dive master, chief scientist Conch abundance and density in this area will be calculated including the collection of biological data. Total allowable catch will be determined including The marine space between 80ft to 140ft will be divided into a grid and drop camera video will be used to locate conch aggregates. Conch aggregates in both <80ft and >80ft will be mapped. Data (e.g. lip thickness, length, habitat type, reproducing) on aggregates 80ft to 140ft will be investigated using specialized human resources trained to dive using nitrox.

Source-sink dynamics of conch larvae dispersal will be investigated to determine connections between populations through the mapping if surface current patterns and through plankton tows. Plankton tows will be conducted near and around conch aggregation sites. Two tows in the vicinity of each conch aggregation will be conducted.

Host two consultations with fishers and other key stakeholders to develop a monitoring strategy and action plan based on the data results and management objectives.

Resources needed

Human resource with expertise in the following will be outsourced

1. Mapping of surface currents
2. Habitat mapping
3. Expertise in identification of conch plankton
4. Expertise in development of closed areas
5. Nitrox divers

Payment of Honorarium for participants

Equipment: Plankton tows (two) 202 micron plankton net with a flow-meter. Rental of SCUBA gear. Purchase of Mesh bags and large calipers for siphon length.

Draft budget (table with some details)

Activity		**Item Cost (US$)**	**Total Cost (US$)**
Rental of SCUBA gear	Wetsuit, Mask and fins	20.00 per use	30 dives per person X 8 people = 240 uses 240 x $20.00 = **$4800.00**
	Tanks (compressed AIR)	20.00 per use	120 sampling points / 4 dive teams = 30 dives per person $20.00 x 30 dives = $600.00 Total $600.00 x 8 divers = **$4800.00**
	BCD	20.00 per use	**$4800.00**
	Regulator	20.00 per use	**$4800.00**
	Tanks (Nitrox)	10.00 per use	$10.00 x 30 dives x 8 divers = **$2400.00**
Boat	Fuel and oil	$25,000.00	**$25,000.00**
	Rental fee	$5000.00	**$5000.00**
Plankton net		$200.00	200 x 2 = **$600**
Mesh Bags		$30.00	30 x 2 = **$60.00**
Stationary		$300.00	**$300.00**
Measuring tape		100.00 (incl. Shipping and handling)	$100.00 x 2 = **$200.00**
PVC rods		$20.00	**$20.00**
Fish Boards		$20.00	**$40.00**
Calipers		200.00	200x 2= **$200.00**
Honorarium for field team (fishers and external stakeholders)		$60.00 per day	$60 x 12 ppl x 30 man days = **21, 660.00**
		Sub total	**$74,680.00**
Expertises for plankton identification (Lab fees)		3000	3000
Habitat mapping (Consultant)		15,000	15,000
Surface Currents (Consultant)		10,000	10,000

Consultations		2000.00	2000.00
Drop Camera		7400.00	**7400.00**
		TOTAL	**$112,080.00**
		10% (estimation factor)	$11208.00
		PROJECT TOTAL	**$123, 288.oo**

Timeline

Total: Six (6) months:

Preparation and Planning: two (2) months

Implementation of survey: two (2) months

Data Analysis and Management recommendations: one (1) month

Development of Monitoring strategy and action plan : one (1) month

Country: The Bahamas

Proposal: Assessing queen conch populations the Bahamas
Prepared by: Jeremy Saunders, Fisheries Superintendent
Institution: Department of Marine Resources, P.O.Box AB 20384, Abaco, Bahamas

Background

Due to the size of The Bahamas' banks, the intent is to initially survey a percentage of the banks. That percentage has not been determined, but very likely to focus primarily on fishing grounds and areas where conch have been reported to be found.

Methods

There is not enough local personnel (certified divers) and other advisor personnel, including GIS experts and survey planners.

It is being considered to use a combination of survey methods, SCUBA, scooters and underwater camera system. Specific details are currently being decided.

Budget

At this moment, it does not appear that we need financial assistance as funding for the conch stock assessment and survey project has been approved by cabinet. We should be able contract the survey experts through this project as well.

Country: Antigua and Barbuda

Proposal: Queen Conch Underwater Visual Survey Antigua & Barbuda
Prepared by: Hilroy Simon, Fisheries assistant
Institution: Fisheries Deprtment, Morris Extension, Old Road Road Village, St. Mary's Parish

Background

The queen conch *strombus gigas* has been harvested by the fishers in Antigua & Barbuda for many leading back into the late 1960s. This marine species has the second highest economic value of all species harvested in the twin island state, second only to the Caribbean spiny lobster. The queen conch industry had a value of approximately 2.1 million Eastern dollars in 2009 and 2010 with landings of 758 & 764 MT (live weight) respectively. There is very little information as the true abundance of the queen conch abundance on the island shelf of Antigua since there has been no fisheries independent survey conducted in the area since 1999. At present all the available conch data are from fisheries dependent surveys making it very difficult to accurately calculate stock biomass in order to determine the TAC for the resource. There is very little information available with regards to the bottom type on the Antigua and Barbuda shelf, it is therefore almost impossible to create accurate habitat maps for the area.

Objectives

The main objectives of this project are:

1) To obtain the data necessary for the creation of habitat maps for the Antigua & Barbuda shelf utilizing underwater visual surveys and drop camera surveys.
2) To acquire baseline data with regards to the population density of the queen conch stocks across the shelf and across different depth and habitat strata on the same shelf.
3) To estimate queen conch biomass
4) To estimate TAC for queen conch on the Antigua & Barbuda shelf
5) To gather information on the deep water conch stocks using towed or remote underwater video camera systems

Methodology

Preliminary Survey

The survey will employ the use of electronic nautical charts to identify and separate the two main depth strata (0-25 meters and 25-40 meters) in order to determine the shallow areas to be surveyed using belt transects by SCUBA divers and the deeper sites to be surveyed using belt transects. Random points will be selected across the entire shelf and divers and drop cameras deployed to gather habitat information. This preliminary survey will also serve as a training platform for local Fisheries Officers and other research personnel who will take part in the actual survey. During this training, the divers the belt transect protocol will be introduced to the surveyors and fine-tuned. The video survey methodology is still in its infant stage, therefore some fine-tuning of the methods and techniques for conducting the deeper water conch survey will be carried out at this stage. The information gathered from these two preliminary surveys will be used to create habitat maps for the Antigua & Barbuda shelf and be used to identify possible areas of aggregation.

Baseline surveys with the assistance of the local commercial conch divers are to be conducted to determine the fished and un-fished areas; this information also will be added to the habitat map for the shelf.

Survey

The stratified random sampling method will be used to determine the location of each sample station. These locations will be uploaded to GPS units to be used in the survey. The stations will be separated into two main categories; shallow sites (<25 meters) and deep sites (25-40 meters). A rugged all weather laptop loaded with nautical software and charts with the GPS interfaced will be used to assist in the navigation and for keeping track or the completed and outstanding stations to prevent the duplication effort.

SCUBA

Due to the extent of the Antigua and Barbuda shelf, covering in excess of 3,500 km2 (appendix 1); seeking assistance from persons already trained in the ACP Fish II “Training in Underwater Visual Survey Methods for Evaluation the Status of *Strombus Gigas*, Queen Conch Stocks” will be necessary in order to complete the survey in a timely manner. For the survey strategy, teams of two SCUBA divers along with one safety diver will survey each station using the belt transect method where four thirty meter transects with the same anchoring points running at a 90° angle to each other. Both side of each thirty meter transect line will be surveyed and the siphonal length and lip thickness measured and recorded on underwater paper for all conchs within two meters of the transect line.

Camera (option 1)

A drop camera will be released at the sampling stations with the camera set at a predetermined angle to capture live footage of the sea floor on the attached Digital Video Recorder (DVR).The DVR and GPS will be interfaced with video overlay so that the GPS coordinates are displayed on the recording in real time. The operator of the DVR will give instructions to raise or lower the drop camera to get the best height for viewing and capturing the data. The vessel will be set to drift after the camera has been deployed and the captain will make efforts to manoeuvre the vessel if the drift is in excess of 3 knots. The points of deployment and retrieval of the camera will be recorded along with the time and water depth.

Camera (option 2)

A ROV equipped with adjustable angle camera, depth control and compass will be deployed at the station and controlled remotely from the surface. This camera will have the ability to get closer to objects (conchs) on the seafloor to confirm their identity. The Video Ray Explorer X3 is equipped to carry out all the functions mentioned above and has a maximum cruising speed of 1.9 knots and the camera is capable of 90° horizontal and 140° diagonal viewing angles, as well as a variable tilt with an 160° vertical field of view. The manoeuvrability of this system also allows for close-ups where it will be possible to get a size reference for each individual conch intercepted.

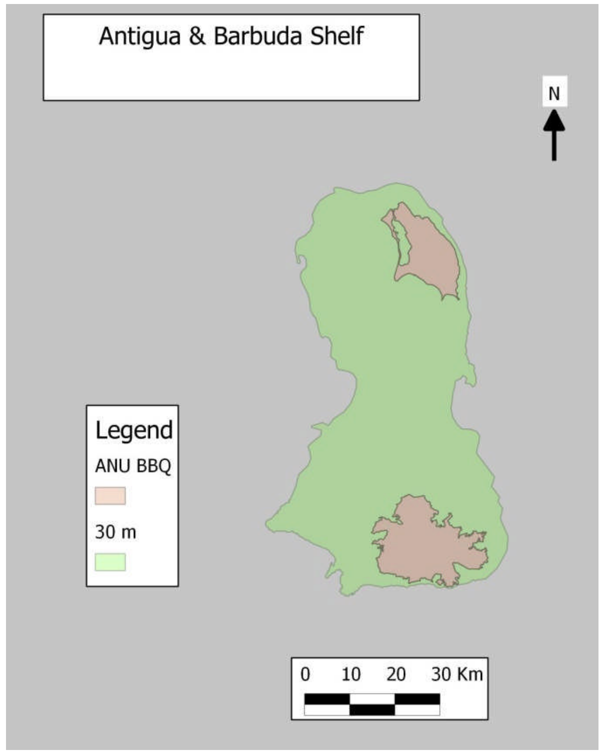
Analysis

All data collected will be uploaded in digital format using Microsoft excel at the end of every dive day using predesigned forms. At the end of the survey the data will be pooled and analysed in Microsoft Excel and the information published and some displays and publications would be made possible using GIS.

Inputs

Available Resources and numbers	**Resources to be Procured**	
	Dive insurance	
SCUBA Equipment = 6 sets	1 X digital camera with waterproof housing	
Dive platforms (Vessel) = 2	4 X Large Callipers 1mm precision	
	4 X small callipers 0.1 mm precision	
	4 X 30 meter measuring tapes	
	1 X Rugged Laptop PC (Panasonic Toughbook)	
	1X Desktop PC	
	1 X Laser Printer/copier	
	200 sheets Waterproof paper	
	2 X GPS units with PC interface	
	2 X Hand held depth sounder	
	6 X Plastic clipboards	
	(a) Video Monitoring Drop Camera	(b) Video Ray Explorer X3 ROV
	1 X Power inverter	1 X Power inverter
	1 X DVR	
	GPS overlay equipment	

Appendix 1: Antigua & Barbuda Shelf



Annex IV.5: Trainees Contact Information and Short Biographies

ANNEX IV. Contact Information and Short Introductions to the Project Participants.

ANTIGUA and BARBUDA

Mr. Hilroy SIMON

Fisheries Assistant
Morris Extension, Old Road Road Village,
St. Mary's Parish
Email: hilroy_simon@yahoo.com
Skype: dirtydouges
Mobile: (268)-464-8177
Office: (268)-462-1372

Hilroy Simon started working with the Fisheries Division in Antigua and Barbuda in January 2001 with special responsibility for fisheries data, however is actively involved in all programs and activities carried out by the department. Being a part of a fishing family and living in a community mainly dominated by agriculture and fishing (also the main conch fishing community), it was easy to understand the needs of the fishers and to assist in developing better relationships between the fisher-folks and the Fisheries Division. He has participated in a few fisheries surveys including the Lesser Antilles Pelagic Ecosystem survey (LAPE) in 2005 – 2007. More recently, he was part of the team that conducted the queen conch morphometric survey conducted in Antigua and Barbuda 2011 and 2012, and presented the findings at the 65th session of the Gulf and Caribbean Fisheries Institute in Santa Marta, Colombia. In addition, he participated in a belt transect coral reef survey conducted in the 2013 summer.

However, SCUBA diving for study queen conch is not a frequent practice in his Department, where free diving is preferred to look at young conch in shallow areas (<20 ft), since the deeper ones come from the fishery. Queen conch fishery has the second highest economic value in Antigua and Barbuda following the Caribbean Spiny Lobster, thus he wants to learn more about this species and how to improve his skills with this training.

THE BAHAMAS

Mr. Jeremie SAUNDERS

Fisheries Superintendent
Department Of Marine Resources
P.O.Box AB 20384, Abaco, Bahamas
Email: jeremysaunders@bahamas.gov.bs;
jas.65@hotmail.com
Office: (242)-699-0203, Mobile: (242)-475-2005

By profession he is a licensed Captain, who is married with a five year old son. He loves boating, spear-fishing, fishing, swimming and football. He has been an employee with The Bahamas Government since 1989 (24years), serving as Fisheries Superintendent, senior office-in charge of The Dept. of Marine Resources – Marsh Harbour, Abaco Office.

BELIZE

Ms. Marsha VARGAS

Assistant Fisheries Officer
Belize Fisheries Department
Princess Margaret Drive
P.O. Box 48, Belize City
Email: marshavargas_2000@yahoo.com
Office: 011-501-2244552

She works at the Belize Fisheries Department for the past 10 years as an Assistant Fisheries Officer. Her responsibilities are related to the data collection, public education and recently more into statistics. She is being diving for the past 11 years, but not recently.

DOMINICAN REPUBLIC

Ms. Elodie FERNANDEZ

Research Assistant
Dominican Council for Fisheries and Aquaculture
Urb. Jardines del Norte
Km. 61/2 Autopista Duarte
Santo Domingo
Email: elodie.fdez@gmail.com
Mobile: (+1) 829-878-8745

She has a French citizenship, grew up in Spain, and moved to Dominican Republic as a teenager, consequently, she is fluent in French, Spanish and English. She graduated as biologist from DR and from Australia (at James Cook University). Her passion is for the ocean, particularly interested in marine invertebrates. During 2011 & 2012 worked as the Coordinator of the Monitoring of Humpback Whales in Samaná Bay for CEBSE, a local NGO. Just recently, she was hired by CODOPESCA as a research Assistant, where queen conch will be surveyed as a result of a new project being carried out by the University of Santo Domingo. The aim of this project is to assess the queen conch stocks at two Marine Protected Areas: Parque Nacional Jaragua and Parque Nacional Montecristi, therefore, is expecting to be able to advice the local team after the completion of this training.

GRENADA

Mr. Olando HARVEY

MPA Manager
Sandy Island Oyster Bed Marine Protected Area,
Hillsborough, Carriacou
Email: landokeri@yahoo.com
Skype: landokeri
Mobile: (473)404-7026; (473)-443-7494

He is a manager of the Sandy Island Oyster Bed Marine Protected Area (SIOBMPA); one of the three formally designated Marine Protected Areas (MPAs) within the Grenada Network of MPAs. He used to work as a seasonal Park Ranger at the Tobago Cays Marine Park (TCMP) for over six years, while he was also studying (at St. George's University undergraduate and at Dalhousie University Master of Marine Management). He was promoted to the Marine Biologist position By 2009-2012.   He is trained in visual resource monitoring protocols including sea urchin, sea turtle and coral reef monitoring, but not queen conch, and also familiar with data analysis using Microsoft Excel along with report preparation.

HAITI

Mr. Jean Christin HENRY

Fisheries Extension Officer
Ministère de l' Agriculture, des Ressources Naturelles et du Development Rural
Route Nationale #1
Port-au-Prince
Email: christin2018@gmail.com

Jean Christin was born in the south part of Haiti, in a place named Jeremie. He graduated as agricultural engineering from the ''UNIVERSITE D'ETAT D'HAITI'' at the "FACULTE D'AGRONOMIE ET DE MEDECINE VETERINAIRE" and later specialized in Natural Resources and Environment. Currently he is working in the fisheries department of the Ministry of Agriculture as a fisheries extension officer.

JAMAICA

Mr. Ricardo MORRIS

Fisheries Officer
Fisheries Division, Ministry of Agriculture and Fisheries,
P.O. Box 470, Marcus Garvey Drive, Kingston 13
Office: (876)923-8811; Mobile: (876)-577-1516
champricky85@hotmail.com
ramorris@moa.gov.jm

He works as Fisheries Officer since 2008, including aspects of queen conch management, scientific assessment by underwater visual surveys held every 3 to 5 years. These surveys may last approximately 2 weeks and involves multiple dives. He is also responsible for monitoring the annual TAC, and for providing technical support to other projects/programmes including habitat enhancement and monitoring which involve monthly dives (both free lung and SCUBA).

ST. KITTS/NEVIS

Mr. Shawn ISLES

Fisheries Assistant
Ministry of Agriculture, Lands, Housing,
Cooperatives and Fisheries
Nevis
Mobile: (869)-664-9745
Office: (869)-469-5521 ext 2154/2161
Fax: (869)-469-0839
thewayoflife1@hotmail.com

During last 12 years Shawn Isles has been a fisheries assistant at the Department of Fisheries in the Ministry of Agriculture in Nevis, with the primary responsibility to collect data for conch statistics on the island. Currently the most experienced person at the Department. While employed at the Department of Fisheries, he has participated in several training courses, including one with JICA (Japan International Cooperation Agency) about stock management and enhancement in Japan, another about lion fish in Nevis, and with the ACP Fish II Programme and the CRFM Ninth Annual Scientific Meeting in St. Vincent and the Grenadines, that organized two different events about *Strombus gigas* or queen conch in St. Vincent and the Grenadines.

ST. LUCIA

Ms. Sarita WILLIAMS-PETER

Fisheries Biologist III
Department of Fisheries
Ministry of Agriculture, Food Production,
Fisheries and Rural Development
Sans Souci, Castries
sarita.peter@govt.lc
Tel #: (758)-468-4139/43/35

She has been working with the Department of Fisheries in Saint Lucia from 2006 as a Fisheries Biologist. As the most senior Fisheries Biologist at the Department, she is responsible for supervising the work programmes of the Resource Management Unit; in addition she has three (3) main responsibilities: 1) to assist in the resolution and execution of complex and/or sensitive operational policy advice and issues, 2) to advise on the leadership and direction of Fisheries Sector operations by participating in strategy formulation, governance process and Department projects, and to initiate the investigation into problems and matters relating to fisheries resource.

Mr. Collins PROSPERE

Fisherman/Conch Diver
c/o Department of Fisheries
Ministry of Agriculture, Food Production,
Fisheries and Rural Development
Sans Souci, Castries
Tel.: (758)-719-5051

He is a 46 year old conch diver and has been diving conch for over 15 years, when began fishing early on life. As an experienced fisherman, he managed to progress and begin his own operation. He sat on the executive of the Gros Islet Fishermen's Cooperative. At present, he is a certified PADI Advanced diver and from 2006 owned a 27 foot fiberglass pirogue to sustain his business. Miss Collins has continually assisted the Department of Fisheries in the management of the industry through more recent a conch survey.

ST. VINCENT AND THE GRENADINES

Ms. Lucine EDWARDS

Fisheries Division
Ministry of Agriculture, Rural Transformation,
Forestry, Fisheries and Industry
Tel: (784)-456-2738 or (784) 456-1178
Fax: (784)-457-2112
Email: fishdiv@vincysurf.com

She has been employed as a Conservation Fisheries Officer at the Fisheries Division in SVG, since 2005. Main duties performed include management of sea turtle conservation programme and coordination of marine protected area development. She has a BSc degree in Zoology from the University of the West Indies, Mona, and MRes in applied Marine and Fisheries Ecology from the University of Aberdeen.

Research interests include cetacean biology and behavior. Is the Current President of the Rotaract Club of Kingtown.

Mr. Kris ISAACS

Fisheries Division
Ministry of Agriculture, Rural Transformation,
Forestry, Fisheries and Industry
Tel: (784)-456-2738 or (784)-456-1178
Fax: (784)-457-2112
Email: fishdiv@vincysurf.com
kris.isaacs@yahoo.com

He is an employee of the Fisheries Officer at the St. Vincent and Grenadines Fisheries Division, in which works at the Biology/Research Unit (of which he is the sole member). Therefore, is responsible for carrying out research needed to provide advice on the sustainable management of SVG's marine resources. For example, design and execute projects to gather information on fisheries interests that have not yet been studied or of which sufficient data may not be available. Additionally, he is part of the Unit liaises with relevant regional and international organizations to facilitate collaboration on the assessment of fisheries resources and the provision of management advice.

Mr. Albert HANSON

Fisheries Division
Ministry of Agriculture, Rural Transformation,
Forestry, Fisheries and Industry
Mobile: (784)-432-4317
Tel: (784)-456-2738 or (784)-456-1178
Fax: (784)-457-2112
Email: fishdiv@vincysurf.com

He is a Marine Park Ranger at the Tobago Cays Marine Park (TCMP) since 1997. He is the chief mechanic as well as one of the two designated captains of the TCMP, and diving is part of his duties. Albert is also certified Reef Check Eco-Diver, trained in sea turtle monitoring (in-water). Working at sea for more than 20 years, has bring to him a significant experience in research for about marine biodiversity. He is very interested in conch monitoring and hope to learn as much a possible from this training.

Ms. Carlina LaBORDE

Laboratory Assistant

Fisheries Division
Ministry of Agriculture, Rural Transformation,
Forestry, Fisheries and Industry
Tel: 784-456-2738 or 784 456-1178
Fax: 784-457-2112
Email: fishdiv@vincysurf.com

Carlina LaBorde has a degree in Agribusiness Management at the University of the West Indies, St. Augustine Campus Trinidad and Tobago, also attended the St.Vincent Techincal College. Currently, she is employed at the Ministry of Agriculture, Rural Transformation, Forestry, Fisheries and Industry (MARTFFI), but use to work at the Fisheries Division. Her duties as laboratory are related to Quality Assurance and Product Development Unit, thus includes water sampling/testing (total chlorine, free chlorine, turbidity, temperature), fish sampling/testing (*E. coli*, *Salmonella*), Inspections (imports and exports) and Issuing Health Certificates to exporters. Prior to working at the Fisheries Division Ms. LaBorde was employed in 2006 at the Plant Protection and Quarantine Unit (PPQ),which is another department in the MARTFFI and worked on the Fruit Fly Surveillance Team.

Mr. Trovan FERARY

Fisheries Division
Ministry of Agriculture, Rural Transformation,
Forestry, Fisheries and Industry
St. Vincent
Tel: 784-456-2738 or 784 456-1178
Fax: 784-457-2112
Email: fishdiv@vincysurf.com
trovferary@gmail.com

He is an employee of the Government of St. Vincent and the Grenadines based at the Fisheries Division in the Ministry of Agriculture, Forestry and Fisheries for the past 11 years. His main responsibilities are: data collection and extension work. His duties include visiting the various Grenadines Islands and meet with the fisher folks and ensuring that the laws and regulations of the State and by extension the Fisheries Division are carried out in correct manner.

Mr. Lorenzo GEORGE

Fisheries Division
Ministry of Agriculture, Rural Transformation,
Forestry, Fisheries and Industry
St. Vincent
Tel: 784-456-2738 or 784 456-1178
Fax: 784-457-2112
Email: fishdiv@vincysurf.com

Mr. Lorenzo George attended the Technical College and the Samuel Jack man's Prescod polytechnic in Barbados where I obtain an associate degree in refrigeration engineering. He began work in the Fisheries Division in 1995 as a Fisheries Assistant. In 2005 was promoted to a Senior Fisheries Assistant (SVG) responsible for: a) Developing and implementation of maintenance plans for all Fisheries Centers refrigeration equipment, fisheries vessels, vehicles and related equipment; b) Developing and implementation of appropriate training programs for fishers, fishermen and equipment operators of fishing plants; c) Carry out workshops on Extension activities such as educating the fishermen on the fisheries regulation and conservation measures; d) Educating fishermen on issues that are affecting the fishing industry; e) Co-ordinate and supervise activities of two Fisheries Assistants within the Fisheries Division. He collaborates with the biology and research, data, conservation and quality assurance units within the department on their work programs.

I have over 15 yrs experience working with fishers in the industry and one of the major highlights was being the liaison Project Officer for the Fisheries Department on the construction of the Owia Fisheries Complex in 2008, at a cost of US$ 33 million. The project was implemented by the Government of St. Vincent and the Grenadines in collaboration with the Government of Japan.

CRFM /ACP FISH II Regional Training Workshop
Underwater Visual Survey Methods of Evaluating the Queen Conch
CRFM Eastern Caribbean Office, August 6-24, Kingstown
St. Vincent and the Grenadines

List of Participants

ANTIGUA and BARBUDA
Mr. Hilroy SIMON
Fisheries Assistant
Morris Extension, Old Road Road Village,
St. Mary's Parish
Email: hilroy_simon@yahoo.com
Skype: dirtydouges
Mobile: (268)-464-8177
Office: (268)-462-1372

BAHAMAS
Mr. Jeremie SAUNDERS
Fisheries Superintendent
Department Of Marine Resources
P.O.Box AB 20384, Abaco, Bahamas
Email: jeremysaunders@bahamas.gov.bs;
jas.65@hotmail.com
Office: (242)-699-0203, Mobile: (242)-475-2005

GRENADA
Mr. Olando HARVEY
MPA Manager
Sandy Island Oyster Bed Marine Protected Area,
Hillsborough, Carriacou
Email: landokeri@yahoo.com
Skype: landokeri
Mobile: (473)404-7026; (473)-443-7494

BELIZE
Ms. Marsha VARGAS
Assistant Fisheries Officer
Belize Fisheries Department
Princess Margaret Drive
P.O. Box 48, Belize City
Email: marshavargas_2000@yahoo.com
Office: 011-501-2244552

DOMINICAN REPUBLIC
Ms. Elodie FERNANDEZ
Research Assistant
Dominican Council for Fisheries and
Aquaculture
Urb. Jardine del Norte
Km. 61/2 Autopista Duarte
Santo Domingo
Email: elodie.fdez@gmail.com
Mobile: (+1) 829-878-8745

HAITI
Mr. Jean Christin HENRY
Fisheries Extension Officer
Ministère de l' Agriculture, des Ressources
Naturelles
et du Development Rural
Route Nationale #1
Port-au-Prince
Email: christin2018@gmail.com

JAMAICA
Mr. Ricardo MORRIS
Fisheries Officer
Fisheries Division, Ministry of Agriculture
and Fisheries,
P.O. Box 470, Marcus Garvey Drive, Kingston 13
Office: (876)923-8811; Mobile: (876)-577-1516
champricky85@hotmail.com
ramorris@moa.gov.jm

ST. KITTS/NEVIS
Mr. Shawn ISLES
Fisheries Assistant
Ministry of Agriculture, Lands, Housing,
Cooperatives and Fisheries
Nevis
Mobile: (869)-664-9745
Office: (869)-469-5521 ext 2154/2161
Fax: (869)-469-0839
thewayoflife1@hotmail.com

ST. LUCIA
Ms. Sarita WILLIAMS-PETER
Fisheries Biologist III
Department of Fisheries
Ministry of Agriculture, Food Production,
Fisheries and Rural Development
Sans Souci, Castries
sarita.peter@govt.lc
Tel #: (758)-468-4139/43/35

ST. LUCIA
Mr. Collins PROSPERE
Fisherman/Conch Diver
c/o Department of Fisheries
Ministry of Agriculture, Food Production,
Fisheries and Rural Development
Sans Souci, Castries
Tel.: (758)-719-5051

ST. VINCENT
Ms. Lucine EDWARDS
Fisheries Division
Ministry of Agriculture, Rural Transformation,
Forestry, Fisheries and Industry
Tel: (784)-456-2738 or (784) 456-1178
Fax: (784)-457-2112
Email: fishdiv@vincysurf.com

Mr. Albert HANSON
Fisheries Division
Ministry of Agriculture, Rural Transformation,
Forestry, Fisheries and Industry
Mobile: (784)-432-4317
Tel: (784)-456-2738 or (784)-456-1178
Fax: (784)-457-2112
Email: fishdiv@vincysurf.com

Mr. Kris ISAACS
Fisheries Division
Ministry of Agriculture, Rural Transformation,
Forestry, Fisheries and Industry
Tel: (784)-456-2738 or (784)-456-1178
Fax: (784)-457-2112
Email: fishdiv@vincysurf.com
kris.isaacs@yahoo.com

Ms. Carlina LaBORDE
Laboratory Assistant
Fisheries Division
Ministry of Agriculture, Rural Transformation,
Forestry, Fisheries and Industry
Tel: 784-456-2738 or 784 456-1178
Fax: 784-457-2112
Email: fishdiv@vincysurf.com

Mr. Trovan FERARY
Fisheries Division
Ministry of Agriculture, Rural Transformation, Forestry, Fisheries and Industry
St. Vincent
Tel: 784-456-2738 or 784 456-1178
Fax: 784-457-2112
Email: fishdiv@vincysurf.com
trovferary@gmail.com

Mr. Lorenzo GEORGE
Fisheries Division
Ministry of Agriculture, Rural Transformation, Forestry, Fisheries and Industry
St. Vincent
Tel: 784-456-2738 or 784 456-1178
Fax: 784-457-2112
Email: fishdiv@vincysurf.com

KEY EXPERTS: SOFRECO

Ms. Martha PRADA
Loma, Perry Hill No. 11-57, San Andres Island
Colombia
Tel: (57)8512-9558
Mobile: (57)312-4343-402
Email: pradamc@gmail.com

Mr. Bob GLAZER
591 Sombrero Beach Road, #3
Marathon, Florida 33050
Mobile (305)942-1814
Email: glazerr1@comcast.net

EVENT COORDINATOR:

Ms. Sherill BARNWELL
Mobile: (784)-532-5145
Email: ms_svg83@yahoo.com

Annex V: Project Communication Releases

Training in underwater visual survey methods for evaluating the status of Strombus gigas, queen conch stocks

CAR/3.2/B.14

PRESS RELEASE

From August 6 to 24, 2013, a group of thirteen resource managers and fishers will meet in St. Vincent and the Grenadines to actively engage in a Training of Trainers workshop focused on queen conch or lambi (*Strombus gigas*) underwater visual census techniques. The lambi is a large mollusk tight to the Caribbean countries for centuries, yet a species lacking fishery information especially in those places where extractive operations continue to be of small scale. With the exception of Jamaica, Belize and to certain extend The Bahamas and Dominican Republic, where the lambi fishery is a well established commercial business, several fishery managers in the CARIFORUM region are forced to take decisions based on very little information. Under this situation the need of reliable information that introduces the application sustainability criteria is a high priority. To counteract the lack of lambi fishery-dependent data, the underwater survey techniques offer a viable alternative that can be implemented in the region, but require training.

This great capacity building opportunity is possible thanks to the support of the European Development Fund on behalf of ACP (African, Caribbean and Pacific Group of states) countries that created the ACP Fish II programme aimed to improve sustainable fisheries management under their jurisdiction. ACP Fish II is beneficiating The Caribbean Regional Fisheries Mechanism with the project entitled "Training in underwater visual survey methods for evaluating the status of *Strombus gigas*, queen conch stocks", currently being implemented by the consulting firm Société Française de Réalisation d'Études et de Conseil (SOFRECO) in coordination with the CRFM. The classroom and field activities (mock survey) organized in this project include the entire process of obtaining a quota recommendation for approximately 248km^2 in and around the Tobago Keys, Mayreau and Union Islands, one of the areas with most lambi in the St. Vincent and the Grenadines. In doing so, aspects on conch biology, survey design, field work preparation, data collection from SCUBA diving and towed-video, data entry, analysis, report generation with management recommendations and regional consideration for extending the queen conch survey in the Caribbean Forum ACP States will be considered. At the conclusion of the project country representatives can have a strategy for sampling lambi for their local conch stocks.

Trainees will be the representatives of the following CRFM member states: Antigua and Barbuda, The Bahamas, Belize, Dominican Republic, Grenada, Haiti, Jamaica, St. Kitts and Nevis, Saint Lucia, and St. Vincent and the Grenadines.

A press event sharing achieved project results will take place upon the conclusion of the practical phase.

MORE-

The ACP Fish II Programme is a four and a half year, EUR€30.0M programme funded by the European Union through the EDF. It has been formulated to strengthen fisheries management, improve food security and alleviate poverty in 78 African, Caribbean and Pacific (ACP) states.

"The cornerstone of the Programme is devising sound policies and plans to ensure sustainable use of fisheries and the development of value-added activities. Therefore, in addition to improving plans and policies at the regional and national levels, ACP Fish II Programme will also see results such as reinforcing the Region's control and enforcement capabilities; reinforcing research strategies and initiatives as well as developing business supportive regulatory framework and increasing knowledge sharing at all levels in the sector", advised Dr Sandra Grant, Regional Programme Manager for the Caribbean of the ACP Fish 11 Programme.

The European Union is made up of 27 Member States who have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The EU is committed to sharing its achievements and its values with countries and peoples beyond its borders. The European Commission is the EU's executive body.

-END-

Full coverage is welcomed.

For further information please contact:

ACP Fish II Programme Regional Manager for the Caribbean Region, Sandra Grant;
E-Mail: s.grant@acpfish2-eu.org; Telephone: 011(501) 223 2974; Fax: 011(501) 223 2975

CRFM : Susan Singh-Renton, DPhil., Deputy Executive Director, CRFM Secretariat,Kingstown,
St. Vincent and the Grenadines.
Tel: +1 784 457 FISH; Fax: +1 784 457 3475; Email: susan.singhrenton@crfm.net

Event Coordinator in Saint Vincent and the Grenadines : Sherrill Barnwell ; Telephone: 1(876) 927 1731

For further information on the ACP Fish II Programme, please visit: http://www.acpfish2-eu.org

An EU Funded Programme

Representatives from Ten CARICOM Countries Successfully Complete Training in Conducting Queen Conch Surveys for Sustainable Management

CAR/3.2/B.14

PRESS RELEASE

A group of thirteen (13) resource managers and fishers are meeting in St. Vincent and the Grenadines to engage in a Training of Trainers workshop, focused on underwater visual census techniques for the queen conch or lambi (*Strombus gigas*).

The queen conch is an iconic part of Caribbean culture as well as a valuable fisheries resource; yet, many countries do not have the knowledge to conduct surveys to ensure the sustainability of their populations.

This is especially true in those countries where the fishery is still small-scale, with the possible exceptions of Jamaica, Belize and to certain extent The Bahamas and Dominican Republic, where the conch fishery is a well established commercial business. Accordingly, many fishery managers in the CARIFORUM region are forced to make management decisions based on minimal amounts of information.

The training—which began on August 6 and concludes tomorrow, August 24, 2013—addresses the critical lack of training capacity for those fisheries managers.

CRFM's Deputy Executive Director, Susan Singh-Renton, remarked that, "This training opportunity has addressed a key step in CRFM's ongoing efforts to improve management of the region's queen conch fisheries through development of a much needed, stronger, scientific approach."

She went on to explain that, "The CRFM is paying special attention to the queen conch fishery resource because of its contribution to foreign exchange earnings for the countries concerned, and related to this, international interest in Caribbean queen conch management and conservation practices."

Trainees represent the following CARIFORUM member states: Antigua and Barbuda, The Bahamas, Belize, Dominican Republic, Grenada, Haiti, Jamaica, St. Kitts and Nevis, Saint Lucia, and St. Vincent and the Grenadines.

The training is divided into two phases: In the first phase, key experts conducted classroom training activities in Kingstown, St. Vincent, by presenting information to the group on the biology and management of conch, as well as survey techniques related to data collection, data analyses. The second phase of the program consists of 9 days of field activities in the Grenadines, in an area of approximately 248km^2 around the Tobago Keys, Mayreau and Union Island. This location represents one of the most important conch fishing areas in St. Vincent and the Grenadines.

The field activities consist of estimating conch abundance using underwater visual census techniques using scuba divers, and by using towed underwater cameras. The trainees participated in all phases of these activities.

After the conclusion of the field surveys, the group reconvened in St. Vincent to analyze the data, make management recommendations based on the surveys, and create conch assessment plans for their own countries.

The entire process is focused on building the capacity for each nation to develop their own sampling programs and subsequently set quota recommendations for conch harvests.

This project was made possible with the support of the European Development Fund on behalf of ACP (African, Caribbean and Pacific Group of states) countries that created the ACP Fish II programme, which aims to improve sustainable fisheries management under their jurisdiction.

ACP Fish II provides benefits to The Caribbean Regional Fisheries Mechanism with this project entitled “Training in underwater visual survey methods for evaluating the status of *Strombus gigas*, queen conch stocks”. The project was implemented by the consulting firm Société Française de Réalisation d’Études et de Conseil (SOFRECO), in coordination with the CRFM.

MORE:

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“The cornerstone of the Programme is devising sound policies and plans to ensure sustainable use of fisheries and the development of value-added activities. Therefore, in addition to improving plans and policies at the regional and national levels, ACP Fish II Programme will also see results such as reinforcing the Region’s control and enforcement capabilities; reinforcing research strategies and initiatives as well as developing business supportive regulatory framework and increasing knowledge sharing at all levels in the sector," advised Dr Sandra Grant, Regional Programme Manager for the Caribbean of the ACP Fish 11 Programme.

The European Union is made up of 27 Member States which have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The EU is committed to sharing its achievements and its values with countries and peoples beyond its borders. The European Commission is the EU's executive body.

-END-

Full coverage is welcomed.

For further information please contact:

ACP Fish II Programme Regional Manager for the Caribbean Region, Sandra Grant;
E-Mail: s.grant@acpfish2-eu.org; Telephone: 011(501) 223 2974; Fax: 011(501) 223 2975

CRFM : Susan Singh-Renton, DPhil., Deputy Executive Director, CRFM Secretariat,Kingstown, St. Vincent and the Grenadines. Tel: +1 784 457 FISH; Fax: +1 784 457 3475; Email: susan.singhrenton@crfm.net

Event Coordinator in Saint Vincent and the Grenadines : **Sherrill Barnwell ;** Telephone: 1(876) 927 1731

For further information on the ACP Fish II Programme, please visit: http://www.acpfish2-eu.org

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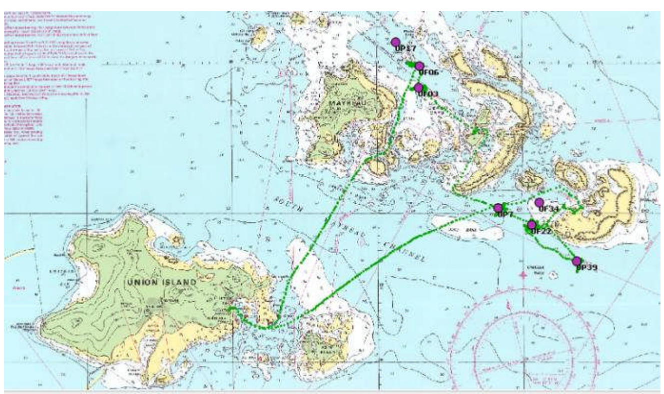
Field Communication Notes Generated During the Southern Grenadines Queen Conch Survey

Log of the Diving Activities

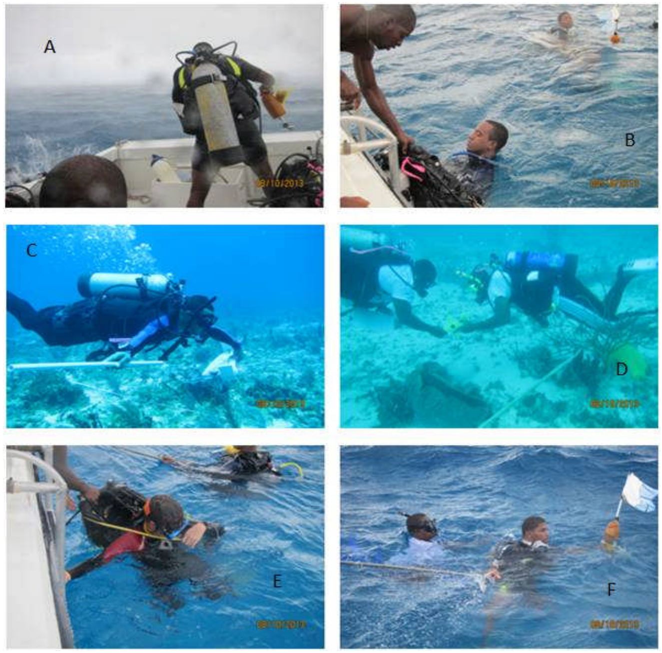
Day one, August 10, 2013
By, Hilroy Simon and Marsha Vargas

At approximately 9:05 a.m. on the 10th August 2013, the ACP Fish II Conch survey team met at the Grenadine's Dive shop to procure equipment for use on the first day of the practical training. The group was divided into two units, with each unit operating from separate boats. Unit one consisted of three teams and the second unit had two teams. At 10:05 a.m. both units left the Clifton harbor and made their way to some pre-determined sites on the outer section of the Horseshoe reef. Due to some inclement weather conditions, both units had to readjust their sites and therefore moved to different locations where sea conditions would have been more favorable since high seas were making the deployment of the divers unsafe and basically impractical. At 11:00 a.m. a squall also moved in which forced unit two to attach themselves to a moorage and wait until it passed, however unit one was able to go ahead as scheduled deploying its first set of divers in the rainy weather conditions. Unit two were unable to deploy their first set of divers until 11:50 am and unfortunately, when the team made their way to the bottom, the substrate was unsuitable for surveying so that dive had to abandoned. The second team however were able to start their transects, however halfway through the operation, a component within the measuring tape broke, which reduced the efficiency of surveying that particular site.

After finishing up the morning dives, both groups convened for lunch on Petit Bateau in the Tobago Cays at 2:05 pm. Lunch lasted for an hour and a half during which the two units were able to discuss the morning's activities as well as get a break from the rocking of the boats while enjoying the beautiful beach and the afternoon's sunny weather. At 3:23 p.m. both Units proceeded to the final afternoon dives. Unit two were only able to complete one team dive because, once again, the surging waves and strong currents, making impossible the second team to be deployed. Therefore Unit two was able to return to the Clifton Harbor at 5:05 p.m. Unit one completed another two dives and returned to the harbor at 6 p.m. At 6:30 p.m. a short debriefing session was held with the entire group, and suggestions were made to improve the efficiency of the operations in the upcoming days.



Spatial location of sites visited (purple dots) and the track for boat one.



Underwater pictures from the first day of diving: A. Dive master Antoine Lewis preparing his entrance, B. Ricardo Morris ending his first dive during a storm, C. Jeremie Saunders looking for conch, D. Albert Hanson and Shawn Isles working together, E. Elodie Fernandez ending her dive, F. Dive master waiting for being pick up.

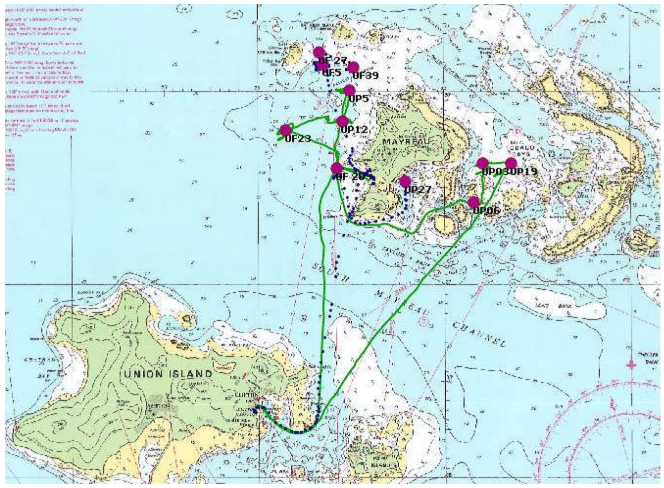
Day two, August 12, 2013
By, Shawn Isles

At 9:00 a.m. on the 12th August 2013, queen conch surveyors departed the pier. Having better weather conditions, researches selected decided to explore sites behind Mayreau island and ended in more protected sites behind the Tobago Cays. The group works out from two platforms, one larger that carry three teams of divers, and the second smaller with another two teams of divers. Despite improved diving conditions, in general divers today found fewer conchs, with the exception that one site where the second boat found 20 young conchs. Stations done today varied between 15 to 5m in depth.

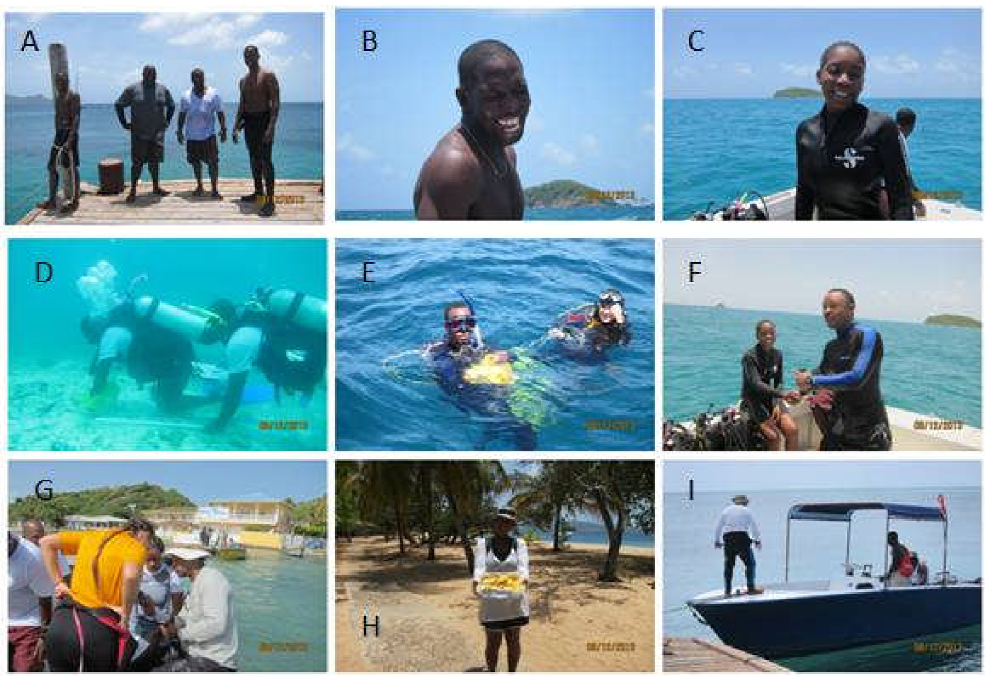
There was a need to relocate station UP12 because it was close to UF23, the new location was shallower and currents were less strong; habitat changed from sand to sparse seagrass, thus showing how patchy the benthic coverage can be. Soft sand bottom habitat with few algae patches was also a habitat found in today's sites.

After the morning dives were completed, both groups took lunch at Mayreau at 12:20 p.m. in a beautiful white sandy beach. The lunch break lasted for one hour and ten minutes. Diving began again at 2:20 p.m. once reaching the stations behind Tobago Cays, where sandy, patchy and sparse corals habitats and transparent water were found. Currents in one of these channels were experienced. Although no conch was observed on several of the transect lines; they were present in some cases just outside. Boat two returned to the harbor at 3:45 p.m., while boat one did it at 4:40 pm.

At 8:00 p.m. participants from Jamaica and Belize made short country presentations, and the group analyzed their strategies and conditions.



Spatial location of sites visited (purple dots) and the track for the boats (green and blue).



Underwater pictures from the second day of diving: A. Olando Harvey, Albert Hanson and Ricardo Morris during the lunch break, B. Palmer (Kimron Allen) smiling, C. Lucine Edwards at the end of her first dive, D. Albert Hanson and Shawn Isles diving team, E. Ricardo Morris and Elodie Fernandez diving team, Lucine Edwards and Jeremie Saunder diving team. Sarita Williams, Elodie Fernandez and Jeremie Saunders revising the GPS waypoints to be sampled, H. Marsha Vargas carrying the lunch, I. Bob Glazer getting ready for afternoon dives.

Day three, August 13, 2013

By, Hilroy Simon

Because of the initial good weather conditions on Tuesday 13th August 2013, our third day of diving, it was decided to survey the exposed sites towards the east of "Worlds End Reef". Dive Teams 1-3 boarded the larger of the two vessels (dive boat 1) while Dive Teams 4 and 5 boarded the smaller vessel (dive boat 2) with both vessels making way at 0920hrs. The journey was short lived as dive boat 1developed steering problems and had some difficulty in maneuvering. Both vessels were alongside the dock seven minutes after the initial departure. Once the solution to the problem was identified, the Dive Operator, Navigators and the Team Leaders decided that in the interest of safety and the completion of the work, dive boat 2 would proceed to two closer stations that were approximately one nautical mile north east of Palm Island, while dive boat 1 can be repaired.

Upon arriving at the station, depth measurements suggested that it was a bit too deep to safely complete the survey at this location. However indications on the charts suggested that this particular sampling station was close to the edge of a deep channel. Some adjustments were made and the sample station was relocated 0.8 nautical miles South East of the original point where the depth was approximately 65ft. A dive marker with a weight belt for anchorage was released to mark the start of the transect. The marker disappeared moments later before divers were able to get into the water. GPS navigation was used to return to point that the marker was released and it was fished out of the water, some more rope added and then redeployed.

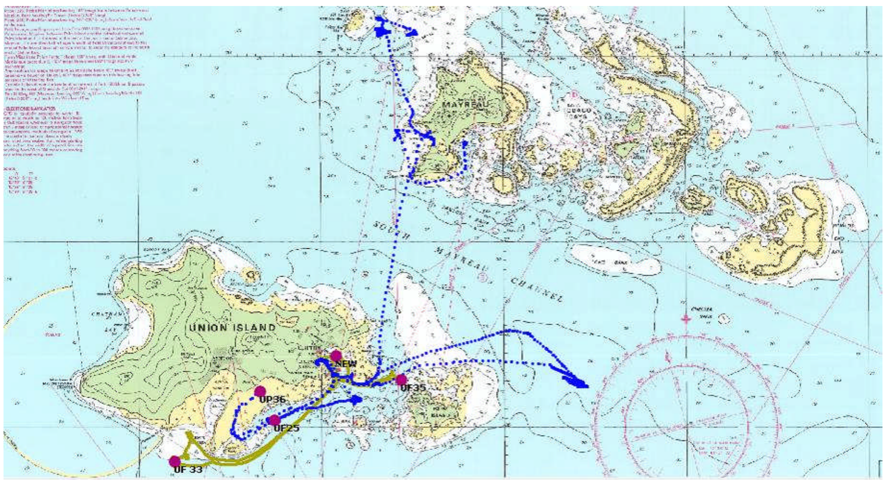
In anticipation of some currents Dive Team one along with Team Leader Mr Bob Glazer and Safety officer "Si" entered the water and began decent at1055hrs to a depth of 66 ft. The current on the bottom was racing towards the North West taking everything with it making it unsafe to conduct surveys at this point. Even with the strong currents, conchs were observed during decent, marker recovery and ascent. Dive Boat 2 then proceeded towards Union Island with intensions of surveying sites located at the South Western side of the island at which point we came within close proximity of Dive Boat 1 which was now on the way with the steering problem fixed.

Both Boat Crews engaged in communications and where it Dive Boat 1 was made aware of the conditions (the strong currents in one direction, but wind on a different direction) and was advised against proceeding to the intended initial stations. Both vessels returned to port to discuss strategies where the help of the Team Members with local knowledge was immeasurable. After the discussions both vessels departed the docking area with Dive Boat 1 heading towards the sheltered side of Palm island where Team 1 was able to complete one dive station (4 transects). Dive Boat 2 proceeding to a shallow lagoon type area closer to the town of Ashton. Dive Team 4 volunteered to survey this site under two conditions; (1) it was less than 10 feet deep and (2) the tanks used in the earlier dive were still contained approximately two-thirds of air. The dive started at 1217hrs at a depth of 6-7ft and was completed within 21 minutes where we then proceeded back to base for lunch arriving at 1315hrs. Dive boat one arrived 15 minutes earlier.

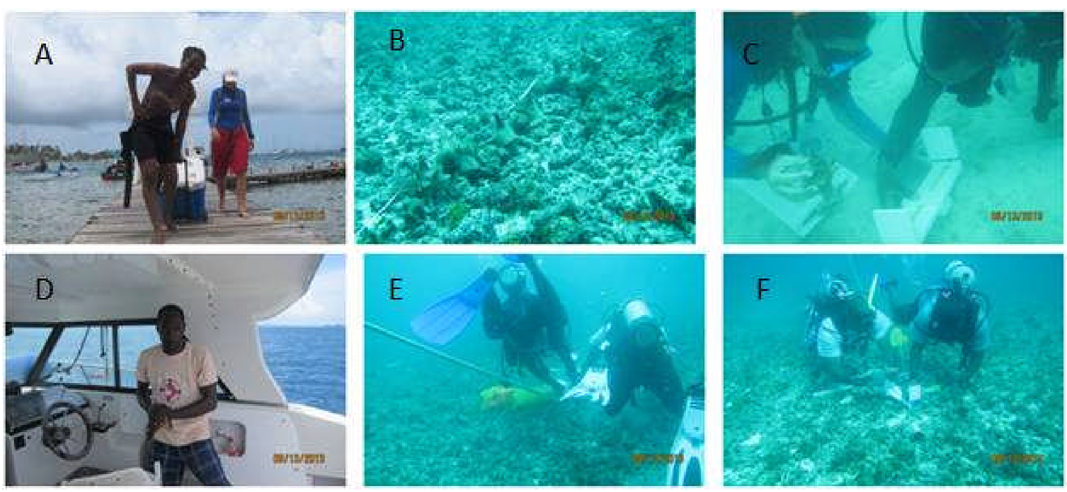
The afternoon session got on the way with the both vessels leaving port at 1400hrs. Dive Boat 2 arrived on site which was just on the outside of the channel into Clifton Harbour at 1414hrs. Dive Team 5 started decent at 1420hrs to a depth of 66ft and surfaced 23 minutes later. It was reported that team was able to complete 3 of 4 transects due to one diver getting close to the air supply limit stipulated by the safety officer. Only 1 conch was reported from this station. Dive Boat 1 surveyed two stations south of Union Island and Team 2 on their first transect encounter 32 conchs on their dive, despite to work on strong currents. Team 3 was able to complete 4 transects on their dive unfortunately no conchs were found. It was necessarily to relocate one station because of the strong currents and add a new station closer to the harbour for the same reason.

Dive Team 4 conducted the last survey site on Dive Boat 2 starting at 1519hrs at a depth of 55ft returning to the surface 31 minutes later. The habitat type at this station was mainly coral reef with very few sand patches. No conchs were observed at this sampling station. Dive boat 1 proceeded to the final dive location at 1630hrs were Team 1 complete their final dive ending at 1705hrs. Dive Boat 2 returned to the docks at exactly 1600hrs.

Again the group met at 8pm, and the team leader Martha Prada presented the case of the queen conch surveys conducted in Serrana Bank. Ideas for adjustments for tomorrow’s diving were discussed, since predictions are that we can have another one or two days under this unfavourable weather conditions.



Spatial location of sites visited (purple dots) and the track for the boats (green and blue).



Underwater pictures from the third day of diving: A. Lucine Edwars and Elodie Fernandez during luch break, B. Queen conch over gravel type habitat, C. Elodie Fernandez and Ricardo Morris working together, D. Jeremiah Forde captain in boat one, E-F. Albert Hanson and Shawn isles diving at a site with plenty conch.

Day four, August 14, 2013
By, Jeremie Saunders and Olando Harvey

Today was again another windy day, seas were running 3-5 feet with moderate swells at 6-7 feet, and winds were estimated at 15-20 knots. Accordingly, it was decided to set a course for the Tobago Cays Marine Park, inside protected sites in the morning and left the exposed sites in the afternoon, where because of the slack tide, currents were expected to be favorable. At 9:15am both boats (1 & 2) leave Grenadines Dive dock for survey stations.

Three dives teams 9:50am and 12:15pm am on board of boat 1 completed their four transects per station, several conch surveyed. The other two dives teams, onboard on boat 2, also conducted their transects successfully.

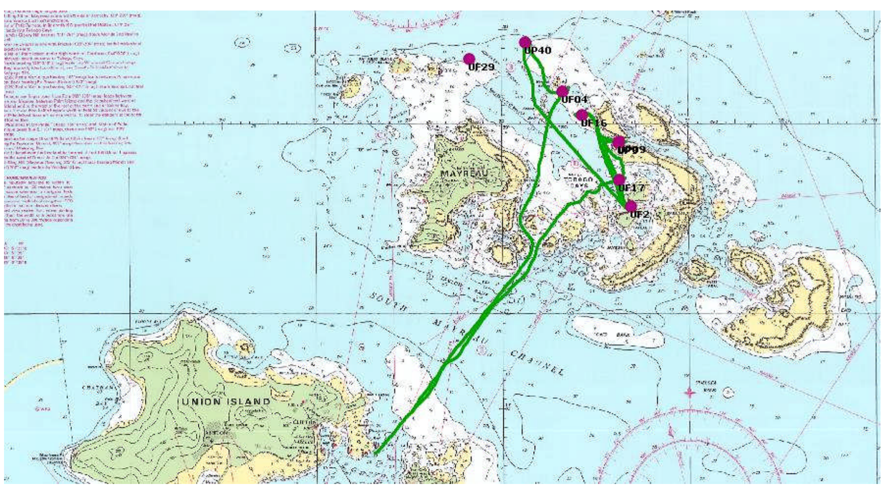
At 12:40 pm boat 1 heads to Petite Bateau for lunch, Group 2 is waiting for us at this location.

Diving began again at 2:05pm, on boat 1, and at 2:00pm on boat 2. All teams were able to survey another four sites, under relative good weather conditions, despite the high surge. Unfortunately majority of the stations did have no conchs, but several dead conch shells were observed.

Both boats we arrived at the dock at 4:15pm.

The group meets again at 8pm to hear another two country presentations, this time conducted by Hilroy Simon who talked about the Antigua and Barbuda case, and Jeremy Sounders who presented the Bahamas case.

Considering that majority of the stations to be surveyed are expose sites, we are in need of better weather conditions.



Spatial location of sites visited (purple dots) and the track for boat one (green).

Underwater pictures from the fourth day of diving: A. Marsha Vargas and Hilroy Simon during the safety stop, B. Olando Harvey and Kris Isaacs working together, C. Kris Isaacs smiling , D. Marsha vargas and Hilroy Simon working together, E. a buried queen conch, F. Sarita Williams looking for a conch, G. Albert Hanson and Shawn isles diving team.

Day fifth, August 15, 2013
By, Sarita Williams-Peter

A total of ten (10) sites were sampled on August 15, 2013 (Figure 1) by a total of ten (10) divers in teams of two (2).

The two research vessels left port at 0935hrs. It was sunny with clear skies. The larger vessel travelled to sampling site UP 11; however the depth of 116ft was not suitable. We set course for an adjusted location about 15 - 20 feet from UP 11 but still the depth was 106ft. There were moderate swells about 5 – 6ft. The original location of sampling point UP11 was aborted and a new coordinate was created at 61ft depth and dived from 1005hrs to 1035hrs. Two (2) conch were found over hard bottom substrate.

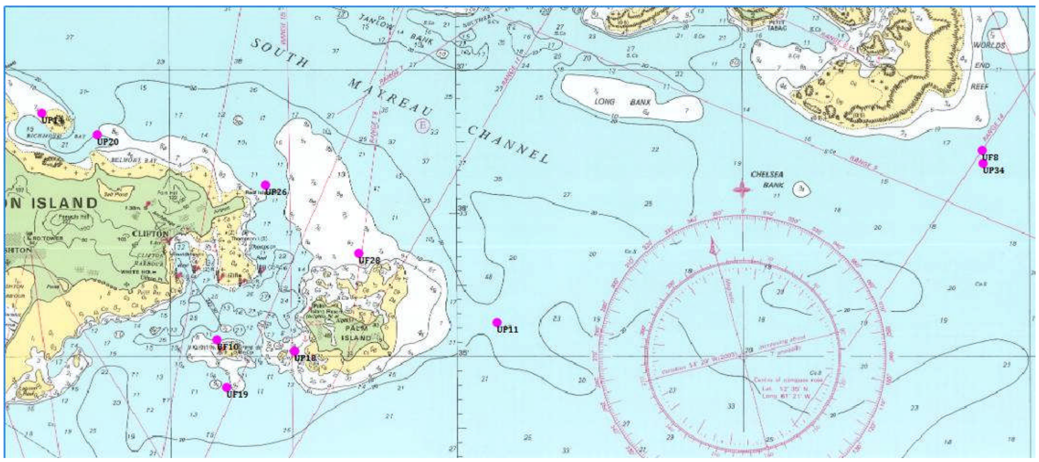
The next sampling point UP15 was also adjusted because the depth was 130ft. Although it was relocated to a shallower area and the swells height reduced, the currents were suspected to be too strong for a safe dive. Since the currents would have been similar in the area sampling site the researchers proceeded to UP28 and dived there from 1110hrs to 1130hrs. No conch was found over the sandy rubble bottom with brown and filamentous green algae.

UP 1 was then dived at 1150hrs but the divers ascended after 8 minutes due to very strong currents making it impossible to swim and run transects. It should be noted that the site had extensive amounts of *Tripneustes ventricosus.* The same dive team that attempted UP1 proceeded to dive UP18, which was about 20ft. Four (4) conch were found mainly sandy patches amidst dense mats of *Halophila* sp. seagrass.

The smaller vessel conducted two dives in the morning at sites UF8 and UP34, both sites at around 19m deep and with a total of 7 conch.

The afternoon weather was sunny and the sea was relatively calm and all sites visited were suitable for diving. At 1418hrs UP26 sampling site was dived. A total of fifty two (52) conch were sampled over the sandy bottom with brown macro-algae and much more were seen outside the transect. UP20 was sampled at 1528hrs; twelve (12) conch were found over the coral and rubble seafloor. Sampling site UP14 was sampled between 1638hrs and 1650hrs. The site had no conch; however an extensive coral reef was found which had a large expanse of healthy Elkon coral (*Acropora palmate*).

The smaller vessel sampled another two sites in the afternoon, UF19 and UF10 both sites with no conch. Smaller boat returned to port at 1540hrs, while the larger one returned at approximately 1720hrs.



Sites sampled for Conch on August 15, 2013 - marked with pink dots.

Underwater pictures from the fifth day of diving: A. Elodie Fernandez and Lucine Edwards, B. Elkhorn coral, C. Marsha Vargas and Hilroy Simon during sampling, D and F. Adult conch on gravel type habitat, E. Albert Hanson and Shawn Isles working together, H-J. Female laying eggs, G. Marsha Vargas and Hilroy Simon measuring conch on sandy habitat.

Day sixth, August 16, 2013
By, Ricardo Morris and Marsha Vargas

Day 6 saw the completion of sampling at 7 stations between the two groups of dive teams and also the completion of the two plankton tows.

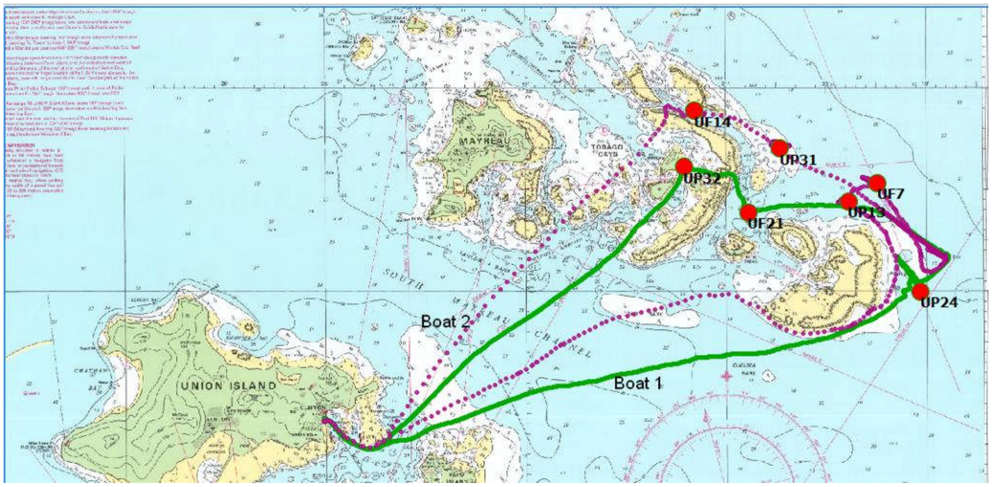
Dive vessel one transporting dives teams 4 and 5 set out at approximately 9:45 am. The late start was mainly due to the sorting out of mechanical issues concerning the second dive vessel. At the end of a discussion it was decided that the boat dive 2 (small one) would go ahead as it was estimated the dive boat 1 (large one) would be able to cast off in short order, heading towards NE of World's end reef to conduct their morning deep dives.

Team 5 (Kris I and Olando H) from boat dive 2 was able to sample station UP31 at 10:20 am at 16.76 m over rubble and algae habitat. Important to note that on transect 3, divers observed a female conch laying an egg mass. The vessel then moved on to station UF7 which was sampled by team 4 consisting of Marsha V. and Hilroy S. from 11:26 am to 11:47 am at depth of 16.76 m. The habitat was coral rubble. The measuring tape broke at about 27 m therefore about 3 transects were about 3 m shorten. Lunch was exchanged on sea between Boat 1 to Boat 2 and was also eaten at sea. Team 5 completed sampling at station UF14 in 7.62 m of depth over rubble habitat, no conch were found on their transects. There was strong current. Following surveyed station by team 4 was at UP13 between 1:52 pm and 2:15 pm on coral habitat with a maximum depth of 16.76 m. The current was strong with a slight surge. Dive boat one arrived at home port at approximately 2:35 pm.

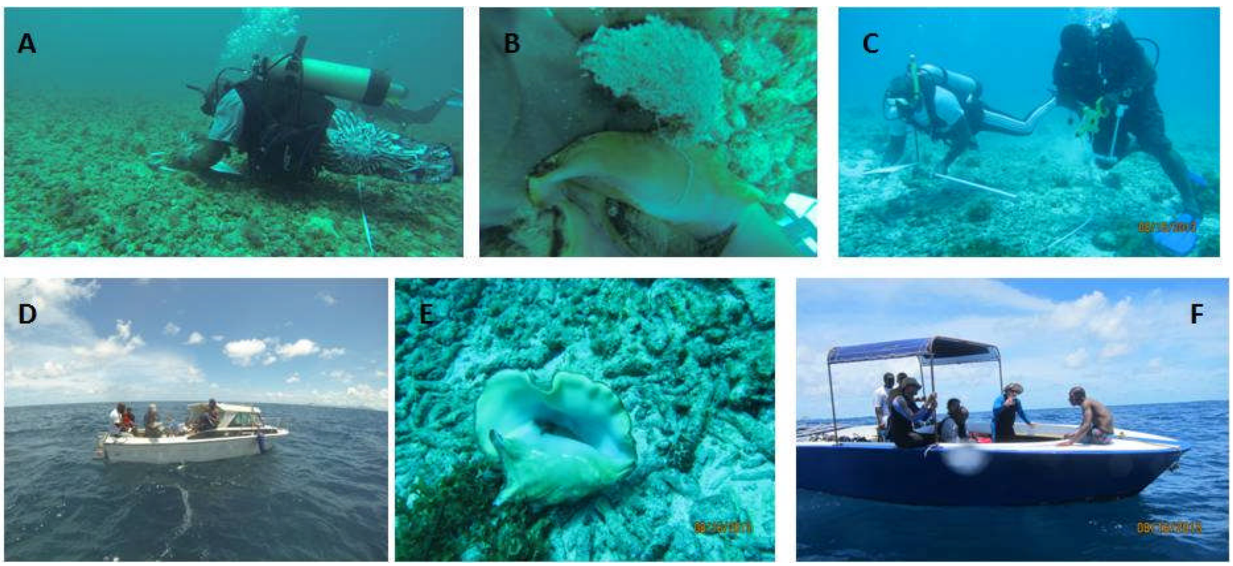
Dive boat 1 transporting dive teams 1 (Ricardo M and Sarita W-P), 2 (Shawn I and Albert H) and 3 (Elodie F and Martha P) left port for the eastern Tobago Cays area at 11:00 am. After arrival at the first station UP24 dive team 2 entered the water at 11:20 am and completed sampling at 12:10 pm. The divers reported high abundance of conch and were thus able to complete only two (2) transects before their air began to run low. While UP24 was being sampled the first plankton tow was conducted. The tow lasted for ten (10) minutes after which the contents were collected for later analysis.

The second dive from boat one was attempted at 12:37 pm by dive team 3 at station UP23 however due to very strong currents below the dive had to be aborted. We were able to move to UF21 where said dive team completed sampling between 1:15 pm and 1:46 pm without incident. The final dive of the day was done by dive team 1 at station UP32 also without incident. The second plankton tow was conducted on this site. After a brief discussion it was decided that we would head back to base as there were no other stations nearby which were considered safe for sampling, thus sampling ended for the day. Dive vessel one arrive at home port at approximately 2:45 pm.

The group convened again at 7:30pm to continue the country presentations, this time made by Kris Isaacs from St. Vincent and the Grenadines and and Olando Harvey from Grenada. Plans were made for our last day of diving!!!



Track and location of the stations surveyed during the sixth day of diving.



Underwater pictures from the sixth day of diving: A. Olando Harvey measuring a conch, B. Female laying eggs, C. Albert Hanson and Shawn Isles doing a transect, D. Boat one waiting for a diver team, E, adult conch with a flared lip, F. Boat two waiting for boat one.

Day seventh, August 16, 2013
By, Elodie Fernandez and Hilloy Simon

Good mood was present all over the place during the setting up of the last scuba diving survey trip by the program “CRFM / ACP Fish II Training in Underwater Visual Survey Methods”. The dive boat one with three teams departed at 9.35am, accompanied by beautiful weather and the calmest waters since the beginning of this survey. The first station was located in one of the most exposed areas at the Southern coast of Union Island, where Sarita Williams-Peter and Ricardo Morris jumped into the water, accompanied by dive master Antoine, at 10:04am to start the Queen Conch survey of the day. After 40 minutes of diving (time out: 10:43am) only one big “juvenile” conch was sampled at 65 feet in a rubble and coral patches habitat. Antoine used his spear gun to catch two lionfish.

The second station surveyed on this boat was located more south-eastern end of Union Island, close to the coast and to the drop-off, however the census was conducted at the shallow portion. This time Shawn Isles and Albert Hanson submerged at 11:03am, while people on-board decided to enjoy free diving. Survey concluded at 11:38am, with no conchs found this time. Depth was about 41 feet and the habitat was coral reef with some patches of sand.

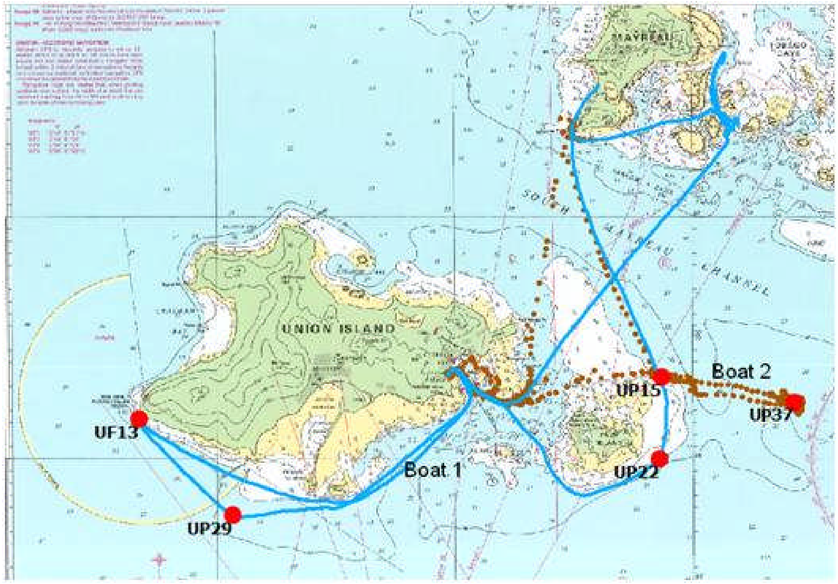
By 12:32pm, Martha Prada and Elodie Fernandez went down on the third and last station of the day for this boat, located on the north-eastern end of Palm (Prune) Island. The survey finalized at 1:07pm after measuring two conchs at 44 feet and in a habitat with patchy soft and hard coral, some rubble, and coarse sand.

Work from dive Boat 2 were conducted by Teams 4 and 5, this time making their second attempt at a station located towards the eastern side of Palm Island arriving at the site at 0955 hrs. Four days earlier strong currents made unsafe to survey this station. Therefore, dive team 4 was able to complete the station in approximately 25 minutes. Eight conchs were found at the site at a depth of 69ft on a bottom composed mainly of coral rubble. The third ten minute plankton tow was conducted at the site with the vessel travelling in a circular anti-clockwise pattern. The contents from the tow were emptied into sample a bottle and alcohol added to preserve the samples.

Next dive on this dive boat 2, still with favorable weather conditions, were done by dive team 5 by descending to a depth of 40ft at 11:25 hrs. One conch was observed at this site and the survey was completed in 20 minutes on a coral rubble bottom. This was also the second attempt at this station as it was abandoned three days ago also due to strong currents.

All divers met for lunch at Mayreau Island by 1:20pm and after some swimming around, both groups did the last dive at Mayreau Gardens (by 2:30pm). Divers “slope drifted” for about 45 minutes, enjoying the view of colorful, live soft and hard coral, mixed with sponges of all colors and sizes, fishes, some nurse sharks, etc. In addition, two more Lionfish were found. The day, as well as the scuba diving survey for this program, concluded at 4:20pm when arriving to the main port at Union Island.

At night the group meet again to hear the last country presentations about the queen conch surveys, this time they were given by Shawn Isles for St. Kitts and Nevis, Elodie Fernandez for Dominican Republic, Sarita Peter for St. Lucia and John C Henry for Haiti. People agree to meet again Sunday at 6pm to meet with Kim Baldwin to hear about the preparation and the methods of the tow video that it will be utilized in the search for the deep water conch population. Albert Hanson and the dive supporting team invited everybody to close our diving activities with fish BBQ!!! on the beach. At this point, we are really integrated, enjoying the hard work, the learning process and the feeling to have now more close friends.



GPS tracks (points blue and red for boats one and two respectively) and location of the last five stations surveyed by diving in this training.

Pictures from the seventh day of dicing: A. queen conch surveys, capture of a lion fish, big adult at Mayreau gardens, B. country presentations, Shawn Isles, Sarita Peter, Elodie Fernandez and John C Henry (from left to right); C. Social event on the beach, Albert Hanson, and the dive supporting team: Kimron Allen (Palmer), Antoine Lewis, Jeremiah Forde and Hyacinth Mayers.

Log of the Deepwater Conch Training with a Towed Video System

Day eight, August 19, 2013
By, Sarita Williams-Peter

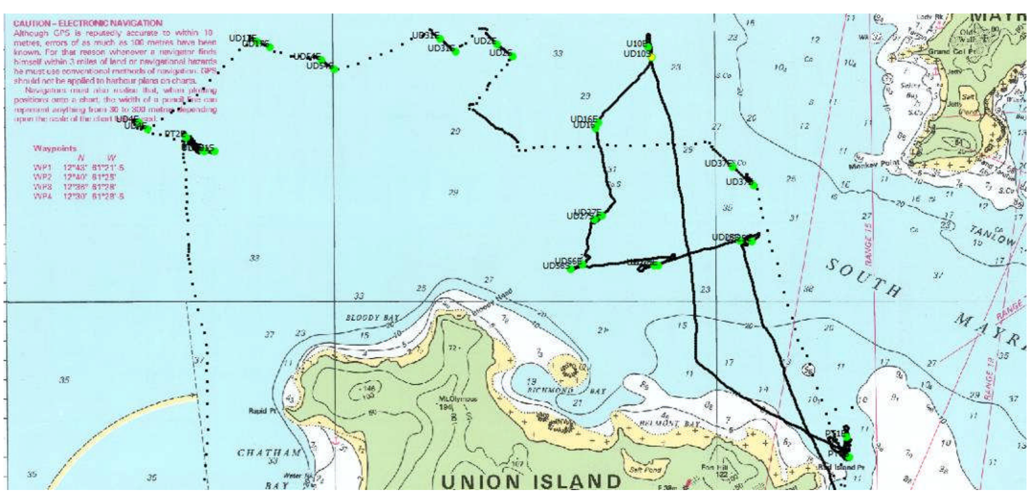
The beginning of the deepwater conch populations using an underwater towed video camera started with the initial talk given by Dr. Kim Baldwin upon her arrival on Sunday Aug 18, 2013.

There were challenges in the stability of the camera frame and rigging the gear to the vessel due to the location of the boat battery. Therefore, it was necessary to make some adjustments in the electrical connections so the power for the system is fitted to the boat characteristics. Half of the group left port at 10:30am to begin the video transects. After the first video transect, which ran for 3 minutes we lost one leg of the frame and so we had a tripod. This we experienced because the frame dragged on the seafloor at times depending on the change in the current and the drift of the boat. On the sixth video transect there was a snag on the video cord and when we lifted the frame we lost two additional legs. Due to the condition of the camera we were unable to continue the transects until repair to the frame. Consequently, we did one plankton tow for 10 minutes.

When we returned to port about 12:30pm and after lunch proceeded to review the camera footage. We realized that the video frames required some adjustment and recommended this to the next team. We did a preliminary count of conch seen in the seven video frames collected – one conch was confirmed with an additional two unconfirmed.

The afternoon group was able to departure around 2:30pm and collected information from 8 sites. Videos clips were collected at depths from 100 and 125 ft. At night the entire group review the clips but this time no conch were observed. Adjustments about the angle of the camera lens as well as its separation from the seafloor are expected to improve with practice. Yesterday, currents were relative high, particularly in the afternoon.

Strategies for conducting queen conch surveys in the region were discussed.



Tracks and waypoints at the sampled stations using the Seaviewer video camera.

Collection of pictures illustrating the use of the underwater video-camera: A. Initial talk with Kim Baldwin, B. The group assembling the underwater video system, C. Initial drops of the video system, D. Sarita Williams and Elodie Fernandez towing the video camera, E. John C Henry making field annotations, F. Lucine Edwards bring back the video system, G. Elodie Fernandez and Lim Baldiwn looking to bottom imagery on real time, H. Elodie Fernandez ready to take a plankton sample, I. Hilroy Simon navigating with the GPS.

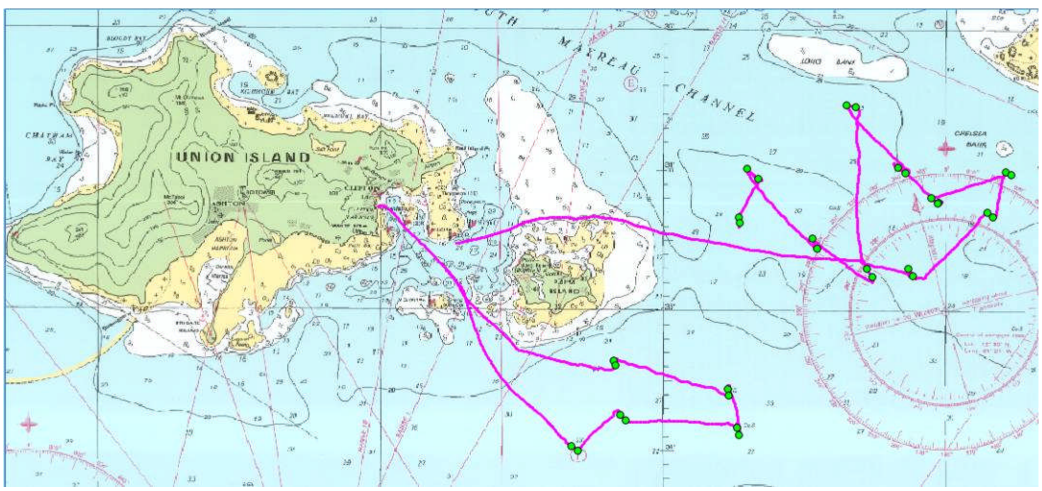
Day ninth, August 20, 2013
By, John C Henry

The last day of data collection started with the second group picture including all participants of the program "CRFM / ACP Fish II Training in Underwater Visual Survey Methods", the dive supporting team and Dr. Kim Baldwin. There was a need to fix some electrical connections before leaving the port, which took only couple of minutes. The morning team left around 10:10am. Unlike yesterday, every single video transect were done easily because all frame legs were carefully attached, even though the sea was terrible. By noon, a total of 10 sites were visited and 3 minutes clips were storage (Table 1). They came back by 12:50pm; the entire group had lunch together.

At 1:30pm, the afternoon departed for their stations, unfortunately the sea conditions were even worse, and thus they were able to search only five sites (Table 1).

Table 1. list of sites visited with the underwater camera in August 20, 2013.

Site code	Start time	End time
UD 21	10:31	10:35
UD18	10:42	10:46
UD6	10:50	10:53
UD30	10:58	11:02
UD20	11:08	11:13
UD34	11:18	11:23
UD51	11:31	11:35
UD12	11:40	11:44
UD52	11:52	11:57
UD15	12:02	12:05
UD38	2:00	2:04
UD7	2:13	2:17
UD57	2:23	2:28
UD28	2:34	2:39
UD33	2:43	2:47



Tracks and waypoints of the sampled stations using the Sea-viewer video camera.

Collection of pictures of the second day using the underwater video-camera: A. Jeremie Saunders holding the camera frame, B. Kim Baldwin and Elodie Fernandez adjusting the camera angle, C. Hilroy Simon making annotations, D. The camera system underwater, E. Sarita Williams holding the cable of the system, F. Group working with the camera system, G. Kim Baldiwn and Jeremiah Forde ready to deploy the camera, H. Shawn Isles making annotations.

Annex VI: Project Photographs

Annex X. Photographs taken during the project implementation. All pictures presented in this annex were taken by Bob Glazer and Martha Prada, the KEs.

Photos taken during project Phase I, in Kingstown and Union Island, St. Vincent and the Grenadines, from June 3-14, 2013.

A. Inception meeting at the CRFM conference room on June 3, 2013.
B. Martha Prada and Kris Isaacs arriving in Union Island for preliminary scheduling of the dive activities with Glenroy Adams from Grenadines Dive, June 4-5, 2013.
C-D. KE participation in the Regional Validation Queen Conch Fisheries held during June 6-8, 2012 at the Methodist Church conference room, in Kingstown, St. Vincent and the Grenadines.
E. KE Martha Prada giving the initial project presentation, June 7, 2013.

Photos of classroom activities during Phase II, at the CRFM conference room, in Kingstown and Union Island, St. Vincent and the Grenadines, from August 6-8, 2013.

A. Trovan Ferary, Olando Harvey and Albert Hanson learning about QGIS.
B. John C Henry, Lorenzo George, Hilroy Simon, Jeremy Saunders learning how to generate a thematic map using QGIS. Bob Glazer is providing instruction.
C. Marsha Vargas, Elodie Fernandez and Shawn Isles doing the same.
D. Martha Prada giving a lecture on field survey methods.
E. Computer screen indicating the completion of a webinar.
F. Bob Glazer giving an presentation on ecotoxicology.

Pictures of field activities including diving during shallow water queen conch survey in the southern Grenadines, from August 9-17, 2013.

A. Nautical chart used for onboard navigation to a selected station.
B. Boat 1 (29 ft) carrying three diver teams.
C. Hilroy Simon, Martha Prada and Jeremy Saunders reviewing the afternoon's stations on handheld GPS.
D. Boat 2 (23ft) carrying two diver teams.
E. Ricardo Morris measuring a queen conch SL with a homemade conch-meter.
F. Olando Harvey measuring queen conch lip thickness with a small caliper.
G. Marsha Vargas and Hilroy Simon revising data at the end of a transect.
H. Kris Isaacs measuring a queen conch SL with a giant caliper.
I. Lucine Edward rolling the 30m-metric tape utilize to mark a transect.
J. Ricardo Morris and Sarita Williams completing a transect.
K. Shawn Isles and Albert Hanson conducting a transect survey.
L. Ricardo Morris and Elodie Fernandez at the surface upon completion of their dive.

Country representatives presenting information about their countries queen conch activities. These presentations were given in the evening after completion of the queen conch surveys, at the Kings Landing Hotel, Union Island, Southern Grenadines from August 12-21, 2013.

Pictures of deep-water queen conch surveys in the southern Grenadines, from August 19-20, 2013.

A. Kim Baldwin gives an evening lecture about the video system components and functioning.
B. Kim Baldwin is coupling the GPS to the DVR for recording the locations on the underwater video overlay.
C. Martha Prada is setting up a Sensus Depth sensor onto the frame of the video camera.
D. Jeremiah Forde, Lucine Edwards, Antoine Lewis and Kim Baldwin prepare to deploy the camera system.
E. Kris Isaacs looking at the DVR monitor, to check video quality in real time.
F. Lucine Edwards and Antoine Lewis deploying the video system.
G. Camera frame and camera in the water column.
H. Shawn Isles, Albert Hanson and Antoine Lewis preparing for a plankton tow.
I. Antoine Lewis during a surface plankton tow.

A-B. Queen conch buried in sand which is difficult to identify by non-trained divers.

C-D. Two young queen conch fishermen that harvest queen conch with SCUBA gear on Union Island.

General pictures from project implementation.

A. The group is preparing to take the fast ferry on Agust 9, 2013 from Kingstown to Union Island.
B. Dr. Susan Singh-Renton welcoming project participants on June 6, 2013.
C. Sherill Barnwell, the SOFRECO logistical coordinator, in Kingstown.
D. Collins Prospere, the fisher from St. Lucia, and other project participants during a classroom lecture.

E-H. Closing ceremony and press event at the Fisheries Department conference room, Kingstown, June 23, 2013.

A

B

A. Group picture at the completion of the classroom activities prior to the field work. CRFM conference room, August 8, 2013.
B. Group picture at the completion of the field work, Kings Landing Hotel pier, August 20, 2013.

Annex VII: Project Video-clip

Annex XI - Script for the Queen Conch Video Detailing the Activities of the Training Program in Underwater Visual Surveys

(The video should last no more than 5 minutes)

Welcome slide with logos detailing ACP Fish II project and title of project.

(Slide 1 - Conch) Narrator: The queen conch is one of the most valuable marine resources in the Caribbean region.

Narrator: The value is in the meat which is used for food, (Slide 2) the shell prized for its curio value (Slide 3), and a small pink pearl found in a small fraction of conch that are harvested (Slide 4).

Narrator: In August, 2013, a group of fisheries managers, officers, and biologists met in Kingstown, St. Vincent and Union Island in the Grenadines to learn how to survey queen conch using underwater visual survey methods (Slide 5,6 – trainees group picture fading into group of people working at computers).

Narrator: In addition to classroom activities, the students engaged in underwater surveys (Video 1). Divers were trained in deploying surveying methods using transect.

Narrator: They first learned how to deploy the measured tapes along the bottom. One diver swims out the transect (video 2).

A second diver swims along the tape and counts all conch within 2 meters of the transect (Video 3). This diver is measuring the width of the transect. Any conch will be measured.

When a conch is encountered, a diver measures the total length of the conch using a measuring tool or a pair of calipers (video 4).

The thickness of the lips is also measured (video 5). The thickness of the lip and the length of the shell provide information that can help managers determine how many conch can be harvested and exported.

Video 6. Interview with trainee.

Slide 7 – photograph of trainees in Union Island.

Scrolling credits including participants names and countries

Annex VIII: Terms of Reference

TERMS OF REFERENCE
FOR
TRAINING IN UNDERWATER VISUAL SURVEY METHODS FOR EVALUATING THE STATUS OF *STROMBUS GIGAS*, QUEEN CONCH STOCKS

(Programme Activity No. CAR/3.2/B.14)

1. BACKGROUND INFORMATION

1.1 Beneficiary country

The direct beneficiary organization is the CARICOM Caribbean Regional Fisheries Organization (CRFM) for the implementation of this contract and the countries involved are Antigua and Barbuda, The Bahamas, Belize, Dominican Republic, Grenada, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines.

1.2 Contracting Authority

ACP FISH II Coordination Unit
36/21 Av. de Tervuren
5th Floor
Brussels 1040, Belgium
Tel.: +32 (0)2.7390060
Fax: +32 (0)2.7390068

1.3 Relevant regional background

CARIFORUM group, the Caribbean Forum of ACP States, comprises 14 CARICOM member states (Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago) and the Dominican Republic. The total population of CARIFORUM countries is 26.37 million, with 75% of the people living in Haiti and the Dominican Republic and four countries having less than 100,000 people. The (weighted) average GNI/capita (PPP, 2006) of the population is US$4,771. In terms of economic well-being, CARIFORUM states range from US$1,509.13 per capita in Guyana to US$19,870 per capita in Trinidad and Tobago. The UNDP Human Development Index (HDI) for 2009, a measure of socioeconomic well-being, ranks Barbados (37^{th}) as top amongst CARIFORUM countries with Haiti (148^{th}) being considered the least developed. The main export products are agriculture, seafood, agro-processing, food stuff, and paper products. The CARIFORUM group is not a homogenous bloc, instead it present diversity in size, language, history, culture, etc. The geography is also challenging with 13 countries being islands and 3 are covered by tropical rain forest.

The ocean environment includes the Caribbean Sea (2.6 million km^2) and the central Atlantic region off the coasts of Latin America, from Suriname to Trinidad and Tobago (310,000 km^2). The living resources in the Caribbean Sea include queen conch, spiny lobster, crabs, mollusks, penaeid shrimps, turtles, marine mammals, and a variety of fish species such as reef fish, small and medium sized coastal pelagic species, large migratory pelagic species, and deep slope snapper and groupers. The nature of fisheries in this region, which stretches from Suriname to Belize and The Bahamas, is varied. It ranges from pelagic stocks off Trinidad and Tobago, shrimp and ground fish off Guyana and Suriname, reef species of the Eastern Caribbean, and conch and lobster stocks of Jamaica, The Bahamas, and Belize. Fish production in CARIFORUM countries was approximately 170,000 MT (average 2001-2006) with an estimated value of over USD 450 million. The per capita consumption of fish in the Region is between 23-25 kg.

The fisheries sector is important for CARIFORUM countries, as it provides employments, enhances food security, and export earnings. It employs over 142,000 persons, directly and indirectly, mostly from rural villages which lack other income earning opportunities. The sector earns over USD 150 million per year from exports and saves the region three times in foreign exchange since the volume of production is four times the volume of export. It accounts for up to 8% of some members GDP. The fisheries sector is a major source of protein in rural communities which have a higher percentage of poverty than the national average. Fishing in the region complements tourism by providing alternative livelihood options such as tour guiding and fishing tournaments.

1.4 Current state of affairs in the relevant sector

Queen conch, *Strombus gigas*, is one of the most important fisheries in the CARICOM/CARIFORUM region. Populations of queen conch can be found along the entire Caribbean chain, from the northern coast of South America, northwards through the Lesser Antilles and Central America, and northwest as far as Bermuda. Queen conch is commercially exploited in at least 22 countries throughout the region, with an estimated landing of about 60 million USD. The fishery represents a significant source of income to fishers and creates jobs for the processing and marketing, ornamental, tourist, and restaurant industries in the region. Annual regional harvests for conch meat range from 4,000 MT to 10,200 MT. Significant conch shells have been exported from the region, with much of the activities originating from Haiti, The Bahamas and the Turks and Caicos Islands (FAO 1999).

In the last 30 years the overall harvest of conch has increased substantially, largely driven by international market demand, as well as growing resident populations, increasing tourism in the Caribbean region, and the expansion of the fishery into previously unexploited deeper waters. These factors have been the main contributors leading to a dramatic decline in conch population densities in several Caribbean countries, which led to the inclusion of queen conch on Appendix II of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) in 1992. Since then, CITES has progressively stepped up pressure on states to adopt resource management and trade related measures to protect and conserve the stocks and to ensure sustainable utilization and trade in the species, including issuance of a CITES export permit for all international trade (Theile 2001[1]).

There are a number of regional and international treaties and agreements to ensure the sustainable use and trade of queen conch. At the international level are the CITES and the Protocol concerning Specially Protected Areas and Wildlife of the Cartagena Convention (SPAW Protocol). At the regional level, several organizations are promoting regional management of the queen conch resources; namely, the Caribbean Regional Fisheries Mechanism Secretariat (CRFM), Caribbean Fisheries Management Council (CFMC), FAO, and several universities and scientific institutions.

According to data obtained directly from countries, the annual harvest of conch ranged from 2,127 to 5,841 MT during the 1990s, while correspondingly higher harvest amounts had been reported to FAO (Tewfik 2002[2]). The data from countries are not believed to reflect the harvest of conch by subsistence fisheries and illegal harvests. Jamaica and the Dominican Republic are the largest producers of queen conch meat with each country reporting annual landings of about 1,000 MT, followed by the Bahamas (453-680 MT) and Turks and Caicos Islands (737-965 MT) per year, and finally Belize with an annual harvest fluctuating between 138-257 MT/year. The queen conch fishery in CARIFORUM countries is predominantly artisanal. In St. Lucia and St. Vincent and the Grenadines conch is targeted by a limited group of divers. In The Bahamas, Antigua and Barbuda, and St. Vincent and the Grenadines, fishers target conch only during the closed season. On the other hand, in Dominica and Barbados, conch is fished opportunistically. In Jamaica, Belize, Dominican Republic, and Turks and Caicos Islands, conch is a major target species for artisanal and industrial vessels the production of which is supported by a developed processing sector that is export oriented. The main fishing gears are SCUBA and compressor (Hookah) diving techniques, except in Belize where these gears are prohibited. In areas where the fishery is more artisanal, harvesting is done by free diving (Theile 2001).

The fishery is carried out by vessels ranging from 7 metre canoes to 35 metre steel hulled ships and may operate on daily schedules but in some cases vessels stay at sea for weeks.

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[1] Theile, S. (2001). Queen conch fisheries and their management in the Caribbean. Technical report to the CITES Secretariat in completion of contract A-2000/01. TRAFFIC Europe: 96 p.

[2] Tewfik, A. (2002). Regional Overview of queen conch (*Strombus gigas*) resources in CARICOM/ CARIFORUM countries, July 2001. CFRAMP: Belize. 30 p.

The status of the queen conch fishery in CARIFORUM counties varies from stocks that appear to be over-exploited to stocks that are considered to be stable. In an effort to manage the fishery, CARIFORUM countries implemented various regulations, including: minimum size restrictions, seasonal closures, gear and vessel restrictions, quotas, and limited entry (Appeldoorn 1997[3]). Although these regulations are in place, there are still a number of concerns: poachers/ illegal fishing; lack of enforcement of existing regulations; inadequate legislation to support implementation of CITES recommendations; the use of modern diving technology, allowing fishers to access the deepest areas (> 30 m) of adult conch habitat which were once spawning stock refugia; and unsafe diving practices as a direct result of no formal dive training, deeper and prolonged diving, poorly maintained equipment, limited understanding of diving techniques, etc.; and overfishing to supply international demand for conch meat.

The need for a common regional approach to manage the queen conch fishery has been identified as the way forward for CRFM Member States. The main issues that need to be addressed regionally are: IUU fishing activities, including poaching and illegal trade; monitoring, control and surveillance; enforcement; the nature and extent of resource sharing through larval dispersal; and regional cooperation in management, including the harmonization of management regulations such as a closed season which could help to reduce illegal fishing. All these issues could be addressed and effectively reduced at the regional level with the cooperation and commitment of Member States. The CRFM Secretariat has taken on the task of coordinating conch management in the region. The overall objectives of queen conch management, as identified by Member States, are conservation of the species, sustainable harvest, and re-building of stocks, where depleted. In order to achieve these objectives, the CRFM Secretariat established the annual scientific meetings to examine information and data from important commercial species to determine their status, and if management objectives are being met. The findings and recommendations of these meetings guide fisheries management and decision-making. The Conch and Lobster Resource Working Group (CLWG) is one of five working groups that conduct fisheries assessments, and it currently strives to provide advice on conch stock/population status and to facilitate the development of appropriate management strategies.

To improve the management of queen conch in the region, Member States need to increase their effort to develop or improve existing data collection systems that will enable better assessment of queen conch impact and population status (CFRAMP 1999). Although many Member States have data systems in place, information gaps exist and the data is usually limited in spatial and temporal scales. While many countries have catch-effort data system (information collected from vessel logs, fisher's interview, processing plant reports, and/or direct sampling at landing sites) and biological data system (information collected from fisheries dependent and independent studies), data collection using visual survey methods is lacking in some countries. Visual survey, identified as being useful in verifying the results of catch-effort analysis, gives fisheries independent details on population structure, estimates of exploitable biomass, levels of recruitment, etc. To date, visual survey assessments have been done in Antigua and Barbuda, Bahamas, Belize, Dominican Republic, Haiti, Jamaica and Saint Lucia. The application of the method was generally similar among countries. Other countries, Grenada, St. Kitts and Nevis and St. Vincent and the Grenadines need to conduct visual surveys in the near future to complement the other assessment techniques being used. As these latter three countries undertake visual surveys there is a need to build on the experiences and methodologies used in the other islands and this proposed regional training exercise will be a valuable opportunity to share best practices and experiences in the use of visual survey techniques. Ultimately this activity will also support the eventual objective of harmonizing visual survey techniques and assessments for queen conch in the region

1.5 Related programmes and other donor activities

The CRFM Secretariat coordinates conch assessment and management activities at the regional level for its membership that includes 14 States that are also members of CARIFORUM. CRFM's mission is to

[3] Appeldoorn R.S. (1994). Queen conch management and research: Status, needs and priorities. In: R.S. Appeldoorn and B. Rodriguez (Eds.): Queen conch biology, fisheries and mariculture, Fundacion Cientifica Los Roques, Caracas, Venezuela. pp. 145-158.

promote and facilitate the responsible utilization of the Region's fisheries and other aquatic resources for the economic and social benefits of the current and future population of the region. The objectives of the CRFM are: (a) the efficient management and sustainable development of marine and other aquatic resources within the jurisdiction of Member States; (b) the promotion and establishment of cooperative arrangements among interested States for the efficient management of shared, straddling or highly migratory marine and other aquatic resources; and (c) the provision of technical advisory and consultative services to fisheries divisions of Member States in the development, management and conservation of their marine and other aquatic resources.

The CRFM Secretariat Strategic Plan, which represents a consensus of Member States priorities, lists fisheries research and resource assessment as one of its main programme areas. The aim of this programme is to conduct research and assessment activities for strengthening the scientific basis for resource management. The CRFM Conch and Lobster Resource Working Group (CLWG) has been established under this programme area to coordinate efforts to address shared issues related to statistics, research, stock assessment and management advice. The overall aim of the CLWG is to improve the technical and information base on lobster and conch and to inform management planning and decision-making.

CRFM has key network arrangements and partnerships among national and regional institutions to ensure successful coordination of fisheries research and resource assessment amongst member states. Namely:

1. The National Marine Fisheries Service (NMFS) research and assessment partnership - collaborate in the completion of key assessment tasks during the annual scientific meetings.

2. United Nations University (UNU, Iceland) research partnership - to develop a fish stock assessment training course suited to fisheries management situations in the Caribbean.

3. University of the West Indies and the Institute of Marine Affairs (IMA) research partnerships – provide general research support and information on fish age and growth respectively

4. CLME project research and assessment partnership - CRFM has been contracted by the CLME project to undertake specific Transboundary Diagnostic Assessment (TDA) and Strategic Action Programme (SAP) activities for large pelagic and flyingfish resources.

5. Japan International Cooperation Agency (JICA) research partnership - regional study on the formulation of a master plan on sustainable use of fisheries resources for coastal community development in the Caribbean

6. FAO research and assessment partnership – provide general and specific support in the area of research and resource assessment. Also, they are currently responsible for execution of TDA and SAP activities pertaining to shrimp and groundfish fisheries under the CLME project.

2. OBJECTIVE, PURPOSE & EXPECTED RESULTS

2.1 Overall objective

The overall objective of the ACP Fish II Programme is to contribute to the sustainable and equitable management of fisheries in ACP regions, thus leading to poverty alleviation and improving food security in ACP States.

2.2 Purpose

The purpose of this contract is to build the capacity of fisheries officers in the target group in using underwater visual survey methods for the management of *Strombus gigas*, queen conch.

2.3 Results to be achieved by the Consultant

The Consultant will achieve the following results as part of this assignment:

- Report prepared analysing fisheries independent approaches for assessment of queen conch in the Caribbean context;
- Training manual on underwater visual survey techniques in the Caribbean developed;
- Fisheries officers trained in use of underwater visual survey techniques.
- Report of Training Workshop completed, including the report of mock survey, visual survey designs for participating countries, and recommendations for implementing the proposed survey design.

3. ASSUMPTIONS & RISKS

3.1 Assumptions underlying the project intervention

Risks for implementation are minimised as the need for this intervention was clearly identified in the Regional Needs Assessment Workshop with fisheries administrations and representatives of Regional Fisheries Bodies (RFBs) carried out in Belize City, 2009. The need for this activity was further confirmed by consultation with the CRFM Secretariat and Fisheries Administrations in participating States.

Since ACP FISH II is a demand-driven Programme, it is assumed that counterpart institutions will take all the necessary measures to ensure the fulfilment of obligations and responsibilities as set forth under this project. Failure to meet that requirement is likely to result in the project not achieving the necessary results.

3.2 Risks

Risks for the implementation of this contract are minimised, since the intervention was identified and endorsed in cooperation with the CRFM Secretariat and Member States. The participatory planning approach adopted in the development of this intervention will continue through implementation to ensure that risks of overlap and poor co-ordination with other initiatives of governments and RFBs will be minimised. In the implementation for a regional programme there are always risks associated with effective consultation with a range of stakeholder groups but through careful planning and scheduling these risks can be properly managed and impact of delays minimised. In this particular assignment there are risks to the successful implementation of the training as a result of poor weather (e.g. hurricanes) so implementation is programmed outside of the regular hurricane season and also careful short-term programming and use of local weather forecasts will serve to minimize the potential risk.

4. SCOPE OF THE WORK

4.1 General

4.1.1 Project description

This assignment aims to train national trainers in the theory and practice to use underwater visual survey methods as a practical fisheries independent method for evaluating the status of the queen conch resource on a regular basis. It is expected that the assignment should be completed in two phases to allow sufficient time for the CRFM Secretariat to conduct additional internal consultations on draft documents and to make the necessary preparation for the training workshop.

In the completion of this assignment the Key Experts (KE) will work closely with the CRFM Secretariat with regional responsibility in both fisheries management and in supporting national administrations in their management of the conch resources. The CRFM Secretariat will be able to provide much of the regionally available data for the study. They also have additional responsibilities, being directly responsible for the co-ordination and providing technical guidance for this project and as such have allocated 30 working days of in-kind professional support to this assignment. The initial briefing will involve the KEs and CRFM Secretariat (Belize and St. Vincent and the Grenadines offices) and together they will review the ToR and develop a workplan for this assignment.

The assignment will begin with an **evaluation** of the use of fisheries independent approaches for assessment of queen conch status in the Caribbean. This evaluation is intended to facilitate a critical review and evaluation of the application of fisheries independent approaches for determination of the status of queen conch, with emphasis on the use of the underwater visual survey method, including field techniques, data collection, storage and analysis, and the types of information generated for management purposes. This task will be supported primarily by: a desktop study of literature and other research and assessment outputs, and remote discussions with national and regional fisheries technical and management experts. The main components of the study are:

(i) Review and evaluation of fisheries independent approaches that have been used for determination of the status of queen conch in the Caribbean region, with emphasis on the underwater visual survey transect and video camera methods and their applications in practice. Advantages and disadvantages of each method should be detailed, based on consideration of inter alia: required and available skills and resources and hence sustainability of method; accuracy/ efficiency of method; suitability of method in respect of its outputs relative to identified management needs.

(ii) Analyse and then detail the steps required for designing an underwater visual survey for queen conch, for each of the transect and video camera methods, to be used in the Caribbean;

(iii) Analyse and detail the steps required in data collection, data storage, data analysis, and reporting, to support application of the underwater visual survey transect and video camera methods for evaluating the status of queen conch, taking into account the available skills and resources in ACP Caribbean States;

Prepare a written report of the process described above as a critical evaluation of use of fisheries independent approaches for assessment of queen conch status in the Caribbean, including guidelines for application in ACP Caribbean States, including the step-by-step process detailed in (ii) and (iii) above. Present report to the CRFM Secretariat and participating States for review and comments, prior to finalization.

The KEs will develop a **training manual** on underwater visual survey methods that includes easily reproducible and customised training materials which participants can use to train officers in their respective countries in the theory and practice to use underwater visual survey methods as a practical fisheries independent method for evaluating the status of the queen conch resource on a regular basis. This training manual, prepared using inputs from the Evaluation Study above, will be the basis of the Training as part of this assignment but will also be adapted for use by the respective officers in their own countries for follow-up training. The draft training manual should be circulated to CRFM Secretariat for review and comments before the workshop.

The **Training of Trainers Workshop**, to be held on Union Island, St. Vincent and the Grenadines, will be a critical event in the assignment and, as with other such events especially in the Caribbean region, careful technical and logistical preparations are required. The workshop will train 12 participants (including 3 local) in the use of the preferred underwater visual survey methods, including field techniques, data collection, data storage, data analysis and reporting techniques. The duration of the Workshop will be 17 working days (including Saturdays) over a 3 week period, and the participants will be selected fisheries officers responsible for research and assessment from the 10 States. The selected fisheries officers must also be certified divers, to enable them to take part in the field training sessions. One technical/scientific officer from the CRFM Secretariat would participant in all workshop sessions and assist countries during field surveys.

An indicative outline of the training workshop is as follows:

- Deliver lectures and other trainer training materials, and supervise practical working sessions in visual survey design, data collection, data storage, data analysis and reporting during the **first 2 days of the Workshop**. Each national representative is expected to bring to the workshop the necessary basic data and information to guide their preparation of a queen conch survey design for his/ her country.
- Design and supervise a local mock **10-day underwater visual survey** of queen conch to facilitate training of trainers in field techniques for both transect and video camera methods. This activity would require a sea-worthy vessel with capacity to hold 12 trainees, 2 instructors, together with required SCUBA and data recording gear for all participants.
- During the final **4 days of the Workshop**, facilitate review of field experiences gained during the mock survey, provide training in entry and analysis of data using data gathered during the mock survey, and provide training in preparation of survey report for management advisory and decision-making purposes.
- One day of the Workshop will be used for the participants to prepare in detail, using the provided materials, a training outline and programme for implementation in their respective countries;

The Consultant will prepare a report of Workshop that includes easily reproducible and customized training materials, the completed report of mock survey, visual survey designs for each participating country, and recommendations for implementing the proposed survey design in each of the participating States. In preparing this report, the Consultant will take into account the findings and recommendations of Phase I. The Report of the Training will be presented to the CRFM Secretariat and participating States for review and comments, prior to finalization.

The Consultant is responsible for logistical arrangements of the Training Workshop including travel tickets booking and delivery, accommodation, for 9 participants and 3 local participants from the mainland St. Vincent, translation (if required), conference room (internet, photocopier, printer, projector, screen, banner, badges, coffee breaks, etc), press/media coverage, and any other activities necessary to complete this activity. Subcontracting is allowed for the organisation of the Workshop. The practical sessions during the 10-day mock survey will require the rental of a sea-worthy vessel with capacity to hold participants, together with rental of required SCUBA and data recording gear for participants, fuel, and crew (captain and dive guide).

Technical Assistance will be provided through a Key Expert team of a senior fisheries assessment and management expert (also Team Leader) supported by a Biologist with expertise in underwater visual survey methods.. In the conduct of the assignment the Key Expert team will be supported by the CRFM Secretariat who will meet regularly and guide the Consultants in implementing the tasks. The Conch and Lobster Working Group should be kept informed of this activity and will be responsible for follow–up in the long term.

4.1.2 Geographical area to be covered

CRFM Participating states include Antigua and Barbuda, The Bahamas, Belize, Dominican Republic, Grenada, Haiti, Jamaica, St. Kitts and Nevis, Saint Lucia, and St. Vincent and the Grenadines.

4.1.3 Target groups

The target group for this activity are the Technical Officers from participating Fisheries Departments responsible for the assessment of queen conch stocks.

4.2 Specific activities

4.2.1 Specific activities

The Consultant will undertake the following activities:

1. Briefing in St. Vincent and the Grenadines with the ACP Fish II Programme and the CRFM Technical Officers, to review Terms of Reference and agree on detailed project work plan;

2. Consult and collaborate with the CRFM Secretariat during the execution of this consultancy for accessing key background documents and ensuring a holistic and integrated approach to queen conch assessment and management activities in the region;

3. With the support of the CRFM Secretariat, identify, collect and review national, regional and international documentation and information related to queen conch assessment and management;

4. Conduct a critical evaluation of use of fisheries independent approaches (with emphasis on under water visual survey methods) for assessment of queen conch status in the Caribbean and prepare a detailed report;

5. Consult with key stakeholders including: government ministries and departments, fishermen organizations/cooperatives, stakeholders, NGOs, research institutions, private sector (as identified by the CRFM Secretariat and Member States);

6. Prepare a draft training manual on underwater visual survey methods in the Caribbean for discussion with CRFM Secretariat;

7. Organise, convene and facilitate a Regional Training Workshop on Underwater Visual Survey Methods in St. Vincent and the Grenadines (17 full working days, indicative number of participants is 12) that includes both theoretical and practical sessions for addressing survey design, implementation, data recording, analysis and reporting;

8. Assist in the preparation of a Press-Release and presentation at a media coverage of the project activity;

9. Prepare and submit Interim and Final Technical Reports including photographic record of the assignment when required.

4.2.2 Communication and project visibility

a) ACP FISH II projects should follow the EU requirements and guidelines for communication and visibility available on the Programme website at http://acpfish2-eu.org/index.php?page=templates&hl=en. The CU will provide ACP FISH II templates for various communication products.

b) Given the important communication potential of the Regional Training for disseminating the results and activities of the Project and ACP FISH II Programme, the following activities will be requested:

- The Consultant will provide all necessary information in press-release style ("information note") on the project objectives and results, the activities to undertake, the main axes or strategic goals proposed and the future role of the beneficiaries.
- The CRFM Secretariat will receive the *Information Note* at least 3 days before the Regional Training Workshop, through their Government communication/press bodies or officials, in order to mobilise local media and to assure full coverage of the event. Financial support to media coverage is included in the "Incidental Expenditure". Receipt(s) of the incurred cost for media coverage will be required to verify the costs incurred.

c) The consultant will provide photographic record of the workshop activities.

4.3 Project management

4.3.1 Responsible body

The Coordination Unit (CU) of the ACP Fish II Programme, based in Brussels, on behalf of the ACP Secretariat is responsible for managing the implementation of this assignment.

4.3.2 Management structure

The ACP Fish II Programme is implemented through the CU in Brussels and six Regional Facilitation Units (RFUs) across the ACP States. The RFU in Belize City, Belize covering ACP Member States in the Caribbean will closely supervise the implementation of this intervention and equally monitor its execution pursuant to these Terms of Reference. For the purposes of this assignment, the ACP Fish II Programme Coordinator will act as the Project Manager.

All contractual communications including requests for contract modifications or changes to the Terms of Reference during the execution period of the contract must be addressed with a formal request to the CU and copied to the RFU. Beneficiaries' support for these changes is required.

4.3.3 Facilities to be provided by the Contracting Authority and/or other parties

Not applicable.

5. LOGISTICS AND TIMING

5.1 Location

The place of posting will be the CRFM Secretariat's Office Kingstown, St. Vincent and the Grenadines. The training workshop will be held on Union Island, St. Vincent and the Grenadines. Field visits in the country will be carried out according to the approved timeline and workplan presented by the Consultant.

5.2 Commencement date & Period of implementation

The intended commencement date of this assignment is 8 April **2013** and the period of implementation of field activities will be 3,5 months from the date of signature of the contract. Please refer to Articles 4 and 5 of the Special Conditions for the actual commencement date and period of implementation.

6. REQUIREMENTS

6.1 Personnel

6.1.1 Key experts

All experts who have a crucial role in implementing this assignment are referred to as key experts. Their profiles are described as follows:

Key Expert 1: Senior Fisheries Assessment and Management Expert and Team Leader
Qualifications and skills
- A post-graduate university degree or equivalent in fisheries, marine biology, ecology, natural resource management or any other relevant specialisation;
- A high level of proficiency in spoken and written English. A working knowledge of Spanish or French will be an advantage;
- Proven team leading skills

General professional experience
- Minimum 10 years of relevant experience in tropical marine resource management, surveys and assessment
- Proven report writing and facilitation skills.

Specific professional experience
- Minimum of 7 years practical experience in gastropod biology, population dynamics and assessment;
- Practical related experience in the Caribbean and knowledge of conch management in the region is an advantage;
- Experience in carrying out similar assignments for the EU or other international development partners (minimum of 3 assignments).

The indicative number of missions outside the normal place of posting requiring overnights for this expert is 1. There will be in-country field visits outside the normal place of posting not requiring overnights for this expert.

Key expert 2: Biologist
Qualifications and skills
- A university degree or equivalent in fisheries, biology, marine ecology, or any other relevant area;
- High level of proficiency in spoken and written English, and a working knowledge of Spanish and French would be an advantage.

General professional experience
- Minimum 5 years experience of gastropod biology and assessment;
- Training and facilitation skills required.

Specific professional experience
- Proven experience in establishment and evaluation of successful gastropod fisheries independent and fisheries dependent monitoring programmes and underwater visual survey methods (minimum of 5 assignments);
- Experience in training for underwater visual survey techniques;
- Previous experience working in the Caribbean would be an advantage;

The indicative number of missions outside the normal place of posting requiring overnights for this expert is 1. There will be in-country field visits outside the normal place of posting not requiring overnights for this expert.

Indicative number of working days by expert and task

No.	Indicative Task	Key Expert 1 (Days)	Key Expert 2 (Days)

1	Briefing by ACP Fish II and CRFM Secretariat	1	1
2	Document review and preparatory work	3	1
3	Conduct analytical study on underwater visual survey techniques	7	5
4	Prepare training manual	5	5
5	Training Workshop (incl. preparations)	22	22
6	Report preparations	2	1
	Total	**40**	**35**

Additional information

a) Key Experts are expected to spend at least 70 % of the total indicative number of working days in the country(ies) participating in this assignment;

b) Note that civil servants and other staff of the public administration of the beneficiary country cannot be recruited as experts, unless prior written approval has been obtained from the European Commission.

c) The Consultant must complete a timesheet using the ACP Fish II template provided by the CU at the start of the implementation period. The Consultant is entitled to work a maximum of 6 days per week. Mobilisation and demobilisation days will not be considered as working days.

6.1.2 Other experts

No other experts will be hired under this contract

6.1.3 Support staff & backstopping

Backstopping costs are considered to be included in the fee rates of the experts.

6.2 Office accommodation

Office accommodation of a reasonable standard and of approximately 10 square metres for each expert working on the assignment is to be provided by the beneficiary.

6.3 Facilities to be provided by the Consultant

The Consultant shall ensure that experts are adequately supported and equipped to conduct all aspects of the assignment. In particular it shall ensure that there is sufficient administrative, secretarial and interpreting provision to enable experts to concentrate on their primary responsibilities. It must also transfer funds as necessary to support its activities under the assignment and to ensure that its employees are paid regularly and in a timely fashion.

If the Consultant is a consortium, the arrangements should allow for the maximum flexibility in project implementation. Arrangements offering each consortium member a fixed percentage of the work to be undertaken under the contract should be avoided.

6.4 Equipment

No equipment is to be purchased on behalf of the Contracting Authority or beneficiary country as part of this service contract or transferred to the Contracting Authority or beneficiary country at the end of the contract. Any equipment related to this contract which is to be acquired by the beneficiary country must be purchased by means of a separate supply tender procedure.

6.5 Incidental expenditure

The Provision for incidental expenditure covers the ancillary and exceptional eligible expenditure incurred under this contract. It cannot be used for costs which should be covered by the Consultant as part of its fee rates, as specified above. Its use is governed by the provisions in the General Conditions and the notes in Annex V of the contract. It may cover:

a) KEY EXPERTS

- Travel costs and daily subsistence allowances (perdiems) for **missions** for Key Experts, outside the normal place of posting, to be undertaken as part of this contract. If applicable, indicate if the provision includes costs for environmental measures, for example CO2 offsetting.
- Travel costs for **field visits** for the Key Experts (car or boat rental, fuel and domestic flights or other appropriate means of transport).

Any subsistence allowances to be paid for missions undertaken as part of this contract must not exceed the per diem rates published on the European Union (EU) website at: http://ec.europa.eu/europeaid/work/procedures/implementation/per_diems/index_en.htm

b) WORKSHOP/TRAINING/CONSULTATIONS ORGANISATION

c) The cost of organisation of the Regional Validation and Training Workshop including cost for venue, communication and media activities, transport (domestic travel or car or boat rental to/from);

d) The payment of a lump-sum to participants requiring an overnight stay to cover accommodation, local transport and meals. This lump-sum payment will be up to 150 EUR and must not exceed the published EU per diem rate for the country;

e) The payment of a lump sum, up to 30% of the published EU per diem rate for the country, to all participants not requiring an overnight stay, to cover the cost of transport and meals;

In the two cases above, an attendance list signed by each participant and a separate list stating that the lump-sum was received (with an indication of the amount) shall be used to justify the expenditure

f) FUNDING OF NATIONAL/REGIONAL OFFICERS ACCOMPANYING KEY EXPERTS ON MISSIONS.

Exceptionally, the cost of flights, accommodation and meals for the representatives of fisheries administrations or regional fisheries bodies accompanying the Key Experts on regional or national missions or in-country field visits**,** under the following conditions:

i) Request of a prior approval to the CU, **attaching to this request the declaration issued by local fisheries administrations or regional fisheries bodies stating that the cost of this extra activity for their officers cannot be covered given the internal budget restrictions. The administration should acknowledge, despite this, the need of the attendance of its officer for an effective project implementation**.

ii) The total cost for accommodation and meals based on actual cost (invoices to be provided) cannot exceed the EU per diem rate for the country.

iii) If private or administration's means of transport are used by the representatives of fisheries administrations or regional fisheries bodies accompanying the Key Experts on regional or national missions, fuel cost will be reimbursed upon receipt of the officer's reimbursement request based on distance travelled and local price for fuel per unit. In case of field visits, not requiring overnights, the same procedures apply for meal and transport costs.

g) TRANSLATION

- The cost of translation of the Draft Final Technical Report and the approved Final Technical Report as well as its executive summary into Spanish and French.
- The cost of translation of the Training Manual into Spanish and French.

h) OTHER

- The cost of producing communication items (banner, flyer, poster), and other technical documents outside normal editing formats to be used in consultations and workshops;
- The cost of renting necessary survey and diving equipment to ensure appropriate and safe operations (including chartering a dive vessel with the services of a suitably qualified and experienced dive master) for the training participants;
- The cost of producing Training manuals and materials for use in the Training of Trainers and for use by the participants in their respective countries;
- The cost of producing up to three extra copies of the Final Technical Report, to be presented to the CRFM Secretariat, upon formal request from local authorities.

The Provision for incidental expenditure for this contract is **EUR 66.070** this amount must be included without modification in the Budget breakdown.

6.6 Expenditure verification

The Provision for expenditure verification relates to the fees of the auditor who has been charged with the expenditure verification of this contract in order to proceed with the payment of further pre-financing instalments if any and/or interim payments if any.

The Provision for expenditure verification for this contract is **EUR 1,500**. This amount must be included without modification in the Budget breakdown. This provision cannot be decreased but can be increased during the execution of the contract.

7. REPORTS

7.1 Reporting requirements

Please refer to Article 26 of the General Conditions. There must be a final report, a final invoice and the financial report accompanied by an expenditure verification report at the end of the period of implementation of the tasks. The approved Final Technical Report (FTR) must be annexed to the Final Report (FR). The final report must be submitted to the CU after receiving the approval of the Final Technical Report (FTR). Note that this final report is additional to any required in Section 4.2 of these Terms of Reference.

The Final Report (FR) shall consist of a narrative section and a financial section. The financial section must contain details of the time inputs of the experts, of the incidental expenditure and of the provision for expenditure verification.

To summarise, the Consultant shall provide the following reports (as requested in section 7.1):

Name of report	Content	Time of submission
Inception Report	Analysis of existing situation and plan of work for the project	No later than 10 days after the first Expert arriving in the place of posting for the first time.
Interim Technical Report	To include agreed draft regional plan of action & detailed plans for the workshop	No later than 10 days after leaving the country after Phase 1
Draft Final Technical Report	Description of achievements, problems encountered, recommendations and technical	Within one week of the experts leaving the country on conclusion of the assignment

	proposals suggested by the consultant and all technical deliverables.	
Final Technical Report	Draft, taking into account changes and comments from the RFU, CU and the fisheries administrations and regional fisheries bodies.	Within 10 days after receiving comments on the Draft Final Technical report (DFTR)
Final Report	Short description of achievements including problems encountered and recommendations and suggestions; together with the Final Technical Report and a final invoice and the financial report accompanied by the expenditure verification report.	Within 1 month of receiving the approval of the FTR

7.2 Submission & approval of reports

Two hard copies of the approved Final Technical Report must be submitted to the Project Manager identified in the contract (CU), one copy to the RFU and two copies to the CRFM. The Final Technical Report must be written in English. The Project Manager is responsible for approving this report. The cost of producing such material will be included in the fees.

8. MONITORING AND EVALUATION

8.1 Definition of indicators

The results to be achieved by the Consultant are included in Section 2.3 above. Progress to achieving these results will be measured through the following indicators:

i. Quality of consultants fielded and speed of mobilisation to the relevant country will indicate a positive start to the assignment;
ii. Reported involvement of CFRM Secretariat and Participating States in delivery of activities;
iii. Technical quality and scope of the Evaluation study of underwater visual survey methods as measured by the scale and nature of amendments required by stakeholders;
iv. Participation and evaluation of Training participants;
v. Quality and scope of the training manual produced;
vi. Number and nature of comments received on the Draft Final Technical Report.

The Consultant may suggest additional monitoring tools for the contract duration.

8.2 Special requirements

Not applicable.